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Knowledge & Scientific News

A MONTHLY JOURNAL OF SCIENCE.

Conducted by MAJOR B. BADEN-POWELL, F.R.A.S., and E. S. GREW, M.A.

VOL. IV. No. 1. [NEW SERIES.] JANUARY, 1907. [Entered at Stationers' Hall.] SIXPENCE NET.

CONTENTS.—See page V.

Lightning Flashes from Earth to Cloud.

By WILLIAM J. S. LOCKYER, M.A., Ph.D., F.R.A.S.

(Continued from page 601, Vol. III.)

The second photograph of an upward discharge, to which mention above has been made, and which is here illustrated in Fig. 5, was taken by Mr. James Craik when he was at Herne Bay some years ago. Here we see both the earth and cloud ends of the flashes, and the ramifications are in both instances directed upwards.

In this photograph we have a unique example, so far as I am acquainted, of two upward flashes photographed on one plate. The third and last photograph, which, I believe, represents an earth-to-cloud flash, is that illustrated in Fig. 6. For this photograph I am indebted to Mr. J. F. Newman, who secured this fine ramified flash at Berkhamsted in July, 1904. This discharge has every appearance of being directed upwards for the intensities of the three ramifications diminish rapidly in the upper portions of the illustration. If the flash were a perspective effect, the branches would most probably be relatively more intense than they are in the photograph.

The above-mentioned photographs give us sufficient evidence to indicate that it is extremely likely that lightning flashes not only pass from the clouds to the earth, but that they sometimes take the reverse direction. Certainly more photographs must be secured before this question can be considered settled once and for all, and herein lies a piece of work that can be attempted by anyone who has even a small camera at his disposal.

Another point that requires investigation is this. It has often been stated that a lightning flash is of an oscillatory character; that is, is composed of a series of discharges, which go back and forth from earth to cloud and from cloud to earth a number of times along the same track.

Thus, to take one instance, in an account of a peculiar flash of lightning which Prof. Kayser, of Bonn, Germany, described in Vol. XLVIII. of the "Sitz. der Kön. Preuss. Akad. der Wissenschaften zu Berlin," he wrote:—

"There remains a fourth and quite satisfactory explanation, that we have here to do with an oscillating discharge, in which flashes in opposite directions take place in very close proximity to each other. Thus the first flash on its way from cloud to earth would leave behind it a channel of heated air; the next discharge from the earth to the cloud would use the same path which would still be in existence, only moved slightly by the wind, &c. . . . That such oscillating lightning discharges occur has been observed many

Fig. 5.—Two earth-to-cloud discharges. Herne Bay. *Photo by Mr. James Craik.*

times by me during violent thunderstorms. One, then, sees the lightning travel several times backwards and forwards; the oscillations must, in consequence, be somewhat slow, otherwise the eye could not detect them individually. Probably such discharges account for an observation made by Dove (Pogg. Ann. 35, pp. 379-380,

Photo by Mr. J. F. Newman.

Fig. 6.—An earth-to-cloud discharge. Berkhamsted, July, 1904.

1835), from which he concluded that such flashes were intermittent discharges."

The above extract shows that Prof. Kayser not only disagrees with Prof. Tait's subjective origin of the observation of the direction of flashes mentioned in a previous paragraph, but appears quite convinced that oscillatory discharges take place. It may be remarked, however, that Dove gave no indication of the direction of travel of the discharges, but simply termed them "intermittent," so that the flash he observed might have been composed of either all cloud-to-earth or all earth-to-cloud flashes.

So far as I am aware, the oscillatory nature of a lightning flash has still to be proved.

This question of oscillation is, however, of great importance, especially when lightning conductors are in consideration. Thus we read ("Modern Lightning Conductors," Killingworth Hedges, 1905, p. 11) that "although it has not been conclusively proved that lightning is oscillatory, it is easier to explain its action on this supposition, and the reason why ordinary conductors are so frequently liable to lateral discharge, is that they are constructed on the incorrect assumption that lightning obeys the same laws as a constant electric current."

Again Mr. Alexander G. McAdie, in "Lightning and the Electricity of the Air" (Bulletin No. 26, U.S. Weather Bureau No. 197, p. 30, 1899), wrote:—

"In the past four years we have learned, through the work of Hertz and others, that when an electric current flows steadily in one direction in a cylindrical wire its intensity is the same in all parts of the wire; but if the current be of an oscillatory character, *i.e.*, a current which rapidly reverses its direction, the condition no longer holds, and if the alternations are very rapid the interior of the wire may be almost free from current. If lightning, then, be a discharge of an oscillatory nature, it may happen that the current down the lightning rod would be only *skin* deep."

These two extracts indicate very forcibly that this question of oscillation of the discharge is well worth inquiring into.

It is, however, not proposed here to consider electrical oscillations which have such small periods of about the order of a millionth or so of a second of time, but simply those whose periods are about one hundredth of a second.

In the first place it is important to draw attention to the fact that we know that what sometimes appears to the eye as a single flash is in many cases a series of separate discharges. This fact has been clearly shown to be the case by photographing such flashes with a moving camera.

Now, what we wish to know is, are such discharges oscillatory; that is, if the components be photographed, are the flashes cloud-to-earth and earth-to-cloud discharges alternately?

Here, again, I think the same method of investigation, namely, the moving camera, may help us, and we may be enabled to detect whether this alternate reversal of the direction of the current does or does not occur.

It has been indicated above that the ramifications of a lightning flash branch off the main stream in the direction of travel of the flash. If, therefore, flashes oscillate, as stated above, then should not the separate images of the ramifications from each individual main flash (photographed on a moving plate) be directed alternately downwards and upwards?

Photo by Herr Walter.

Fig. 7.—A multiple lightning flash, showing the ramifications of the separate discharges, all directed towards the earth. Hamburg, May 30, 1902.

Now what do photographs taken in this manner inform us? In every single case, and a whole host of "multiple" flash photographs has been examined, the ramifications are all turned towards the earth; that is, all the individual flashes were cloud-to-earth discharges.

As an illustration of one of the photographs bringing out this point very clearly, let me put before the reader this reproduction (Fig. 7). For the use of this photograph I am indebted to Herr Walter, of Hamburg, who secured this most interesting "multiple" flash photograph on the night of May 30, 1902. The motion of the camera was directed horizontally by means of a special mounting operated by clockwork. In this case the first flash that fell on the plate was that on the left, while those towards the right occurred subsequently. As will be seen, this flash was really composed of five individual flashes, although to the eye it appeared single. The intervals of time between the individual flashes, counting from left to right, were 0.036, 0.036, 0.028, and 0.144 seconds, and the total duration of the discharge was 0.244 seconds, according to Herr Walter's statement.

On examination it will be noticed that the first flash was from cloud to earth, the ramifications being directed downwards. In the second flash also the same direction was maintained, and the branches, although fewer in number, were also directed towards the earth. It is worth while drawing the reader's attention to the faintness of the fourth ramification from the top of the first flash and to its great increase of intensity in the second flash. This indicates in a striking manner not only that the direction of the electric current remained the same, but that even this subsidiary path already made for it by the previous flash was more fully utilised by the second.

As the cloud was being discharged, so the flashes became weaker and weaker, and the ramifications fewer, until the final flash is the least intense of the five, and is devoid of all ramifications. In no case have any of the branches an upward direction, so that in this instance it must be acknowledged that all the flashes were from cloud to earth.

It has been pointed out to me that it does not necessarily follow that, because all the ramifications on the individual images were directed towards the ground, the discharge is not of an oscillatory nature. The reason given was that the first discharge would so "ionise" the atmosphere along the path it took in going from earth to cloud, that the return flash to the cloud would find the least resistance along the same track, including even the ramifications. If this be granted for a moment, an examination of the photograph from many points of view suggests that this is not the case.

Since the flash on the left in Fig. 7 was the first to occur, this discharge is necessarily a cloud-to-earth flash, because the ramifications are directed downwards. Assuming, then, that the second flash is a discharge from earth-to-cloud, should not its bottom or earth end be stronger than its cloud end, and also stronger than the earth end of the first flash? The photograph does not endorse this view.

Again, how can the strongest ramification of the second flash be explained if the main flash be an earth-to-cloud flash? It seems to me that the peculiarities of this series of flashes are quite easily explained if the assumption be made that the discharges are all in the direction of cloud to earth.

It is quite possible, however, that the photographs already examined were "multiple" flashes, but not of an oscillatory character. It would, therefore, be of great interest if those who photograph lightning flashes would sometimes employ a moving camera to try and obtain records of "multiple" flashes, which exhibit ramifications which are alternately directed to earth and to cloud.

Having drawn attention to the occurrence of earth-to-cloud lightning discharges, as exhibited in a few photographs which I have been fortunate enough to secure, it is very probable that many more photographs are in existence which are of a similar character. It would be useful, therefore, if those who possess lightning-flash photographs would examine them critically from this point of view, for it seems that such discharges are of more common occurrence than was at first believed.

Should such a search be the means of bringing together a greater number of specimens of earth-to-cloud flashes, a great favour would be conferred on the writer of this article if he could be informed, because it is only by the close study of many of such photographs that valid conclusions can be drawn.

Observatory of the Ebro.

Notes of the 1905 Eclipse.

MANY circumstances have combined to render the foundation of a new Spanish observatory of great interest and importance. There is first the feeling of not unnatural surprise at such a happening in a country which had for many years been regarded as non-progressive, and by some writers freely labelled decadent, dying, effete, or some other equally uncomplimentary epithet. Signs of revival are now more numerous, and a King on his own feet with an English Queen to sympathise with his modern ideas bids fair to modify many of the harsh criticisms passed of late years upon his historic heritage. Yet the observatory is only in a sense of Spanish growth. It is the latest branch of the scientific activity of the powerful Society of Jesus, whose labours at Kalocsa, at Herény, at Stonyhurst, at Georgetown, D.C., at Havana, at Manila, and many other posts are landmarks in the domains of astronomy and cosmical physics.

In succession to the late Father Juan, Father Cirera, in charge of the magnetic department at the Philippine Observatory, pursued the investigation of the periodic variations of the magnetic elements until circumstances, possibly not unconnected with the change of ownership of those islands, which did not, however, involve any immediate stoppage of the work, recalled him to Spain. Loth to give up the investigation to which for more than ten years his energies had been applied, Father Cirera obtained the sanction of the Provincial Head of his Order to the establishment of an observatory in Aragon, at which that work might be continued.

The question of funds had, of course, to be considered, in addition to the choice of situation and equipment, and several years were devoted to preparation. Most of the best known European observatories were visited in turn, and much time spent in picking up new ideas at the Paris Exposition; in fact, a whole year was spent in Paris, and ten months at Stonyhurst, shorter visits being paid to Kew and Greenwich, and at the beginning of 1902 a site was chosen which possessed the strong recommendation, among others, that it lay within the region of totality for the eclipse of August 30, 1905, which incidentally fixed a date before which the installation should be, if possible, completed.

Father Cirera had been struck with the poverty in modern electrical and seismological equipment of the observatories of England and France, and proceeded to those of Belgium, Germany, Austria-Hungary, and

Italy to supply the deficiency. Enlisting the powerful aid of a wealthy Spaniard residing in Paris, plans were soon drawn up for the buildings to be erected on the chosen site near Tortosa, on a small eminence in the valley of the Ebro, inconveniently far from a town for building purposes, but for that very reason the better suited for a magnetic observatory. The interest aroused in the Jesuits' "General," following on the en-

Photograph of the Corona at Vinaroz.

thusiasm of Señor Landerer, perhaps the best qualified astronomer in Spain, who assured the Superiors that if they made haste their observatory would be the first of its kind, in fact absolutely unique, caused them to sanction the pursuance in its entirety of a scheme from which, had they fully realised its financial magnitude, they might well have shrunk.

Imagine the delight of a director given *carte blanche* or nearly so, and how he would revel in the very latest devices for each of his departments. It is not surprising that his long sojourn at Paris encouraged him to entrust the orders for apparatus very largely in that centre; but wherever other nations had specialised, the advantages of Paris were at once foregone, so we find the new observatory equipped with an English magnetometer, Italian seismic instruments, and certain electrical and meteorological contrivances of German make. The Rowland grating also is not of Paris origin.

The new instruments were tested just where Father Cirera thought the testing would be easiest or most reliable, usually in the country of origin—the Dover magnetometer at Kew, the dip instrument at Potsdam, the spectroscopic apparatus at Meudon, and so on. Eschenhagen's dip apparatus found an ardent admirer in Father Cirera, for whom it was difficult, if not impossible, to understand why Greenwich feels bound to adhere to the principle of continuity.

Whenever resources ran short, Providence, in Father Cirera's pious narrative, found new patrons both in the Spanish colony at Paris and also in Barcelona; and when apparatus began to arrive many distinguished scientists of the Jesuit confraternity seemed to be available to lend their valuable assistance at the new installation—just returning from foreign posts or just preparing to take up work abroad.

Yet, after all, things were not quite perfect in time for the eclipse. Many adjustments had to be postponed, as they would take too long, and the eclipse must be considered first. The magnetic basement was uncomfortably damp until time was found to isolate it by means of a deep trench from persistent infiltration on one side. A second coelostat was presented in time for the eclipse, but there was not time to alter the arrangement by which the first one had to do duty for two instruments. The spectroheliograph, again, was unsatisfactory, and had to be returned to the makers, but was meanwhile used for the eclipse. Other improvements in lighting and re-arrangement of buildings have taken place from time to time. There is a 4-horse power Crossley dynamo-motor, and a set of accumulators; also a large acetylene generating station, so that neither light nor power (*e.g.*, for maintaining water supply) is lacking in any part of the domain, about which a few words of description are necessary. Situated in N. latitude 40° 49′ and slightly to the East of Greenwich, though less than two minutes from the prime meridian, it lies about a mile from the right bank of the Ebro and twelve from the sea, on the borders of Catalonia and Valencia, its local situation being on a small elevation similar in height to Greenwich hill, but not so steep. Communication is easy, for a few minutes' walk brings one to the horse-tramway from Roquetas to Tortosa, a station on the Barcelona Railway, but there are no electric trams, no minerals, no basalt formation, so that the place is very suitable for a magnetic observatory.

Photograph of the Corona at Vinaroz.

Magnetism is, however, only a branch of the work, which aims at the investigation of every effect of the sun on the earth, and so includes, of necessity, not only every branch of meteorology and atmospheric electricity, including even such special researches as the ionisation of the atmosphere, but also an astrophysical laboratory, in addition to the indispensable astronomical time service.

The instrumental equipment includes a twin equatorial of 6½-inch aperture, the visual of 8 feet focus and the photographic of 7 feet, with an enlarger giving an 8-inch image, an Evershed 2-slit spectroheliograph, a spectrogoniometer, and a prominence spectroscope. These, with a Grubb cœlostat and a Rowland grating practically complete one department.

Most of the meteorological registers are obtained with Richard instruments, but there are other forms of apparatus—for measuring the total number of ions per volume of atmosphere (Gerdien), the relative numbers of positive and negative ions (Elster and Geitel), Hertzian waves (Branly), and electrical potential (Mascart). An Arago actinometer with black and bright bulbs *in vacuo* is employed, and an Angström pyrheliometer, as recommended by the Solar Union, whose Oxford meeting Father Cirera attended. In addition to the Besson nephoscope is another with a wide angle lens in the roof of a sort of kiosk, which produces an image of the sky and clouds on a table below, something after the manner of a camera obscura, rendering measurement very simple.

One interesting feature of the photographic magnetographs is the use, instead of "hour" breaks, of an extra lamp only lighted at the hours, causing a black line across the trace instead of a white one, and enabling the adjustment of the "hour" light for any period from 1 to 80 seconds as required.

Time presses, and we must leave many interesting details, only noting that a daylight time signal being insufficiently conspicuous, owing to distance from the centres of activity, where it would be of value, a night signal with white and green lights has been substituted, ending at 9 p.m. The neighbouring Jesuit college for advanced students, to which, in a sense, the observatory is an annexe, provides some assistance, and demands some training and lectures, and there are also regular days and hours for visitors.

For the eclipse, preparations on a special scale were made. Jesuits from all parts of the world were freely invited to Spain, and though many well-known scientists declined, owing to press of other work, yet quite a large number accepted, and arrangements were made to spread out along the Spanish totality track such of the visitors as brought their own equipment, leaving those totally unequipped to assist either at the new observatory or elsewhere, in order not to risk loss through too great concentration.

Briefly, the local programme comprised visual observations of times of contact and chords, photographic observations of internal contacts, spectroscopy, polarisation, photography and drawings of the Corona, photometric observations, shadow-bands, atmospheric ionisation and electric potential, Hertzian waves, and solar radiation; also atmospheric temperature and humidity, observations of plants and animals, variation of magnetic elements, and earth currents.

It was unfortunate that light clouds in great measure interfered with the more delicate spectroscopic part of the programme, and to a less extent with other portions, but the truly comprehensive nature of the programme gives a good indication of the scope and possibilities of the new observatory, while in some directions, notably in the magnetic observations, so strongly insisted on by the editor of *Terrestrial Magnetism*, a distinct success appears to have been achieved. The smaller expeditions to other places in the zone, including that under Father Cortie at Vinaroz, and of the German Jesuits at Burgos, were more or less successful, but do not so conspicuously belong to our present subject. Illustrations from "Mémoires de L'Observatoire de L'Ebre," No. 1.

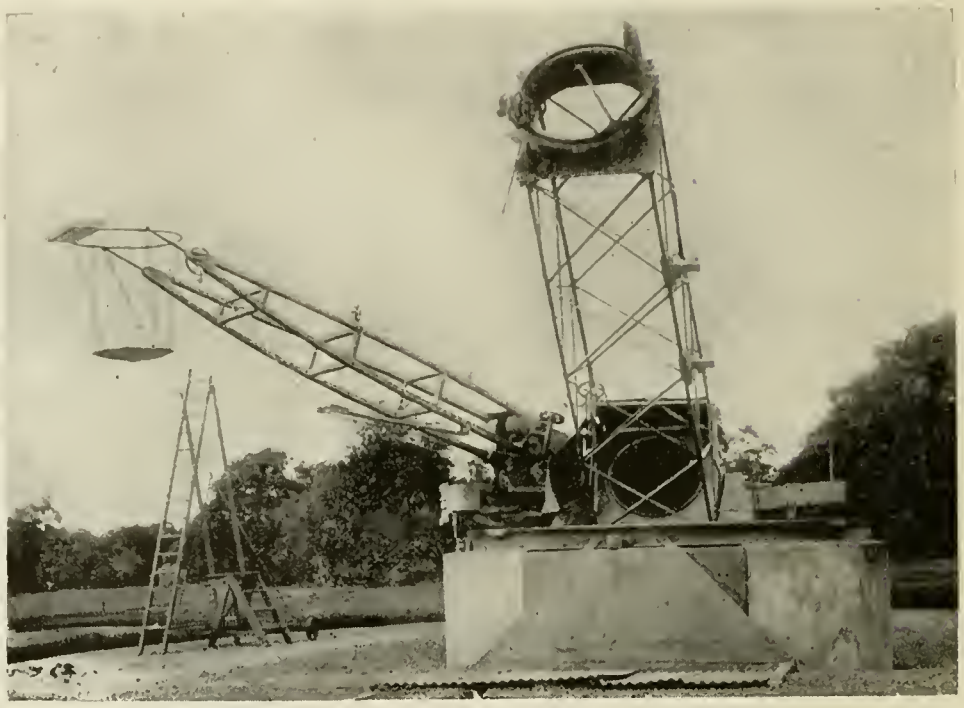
Lord Rosse's Smaller Telescope.

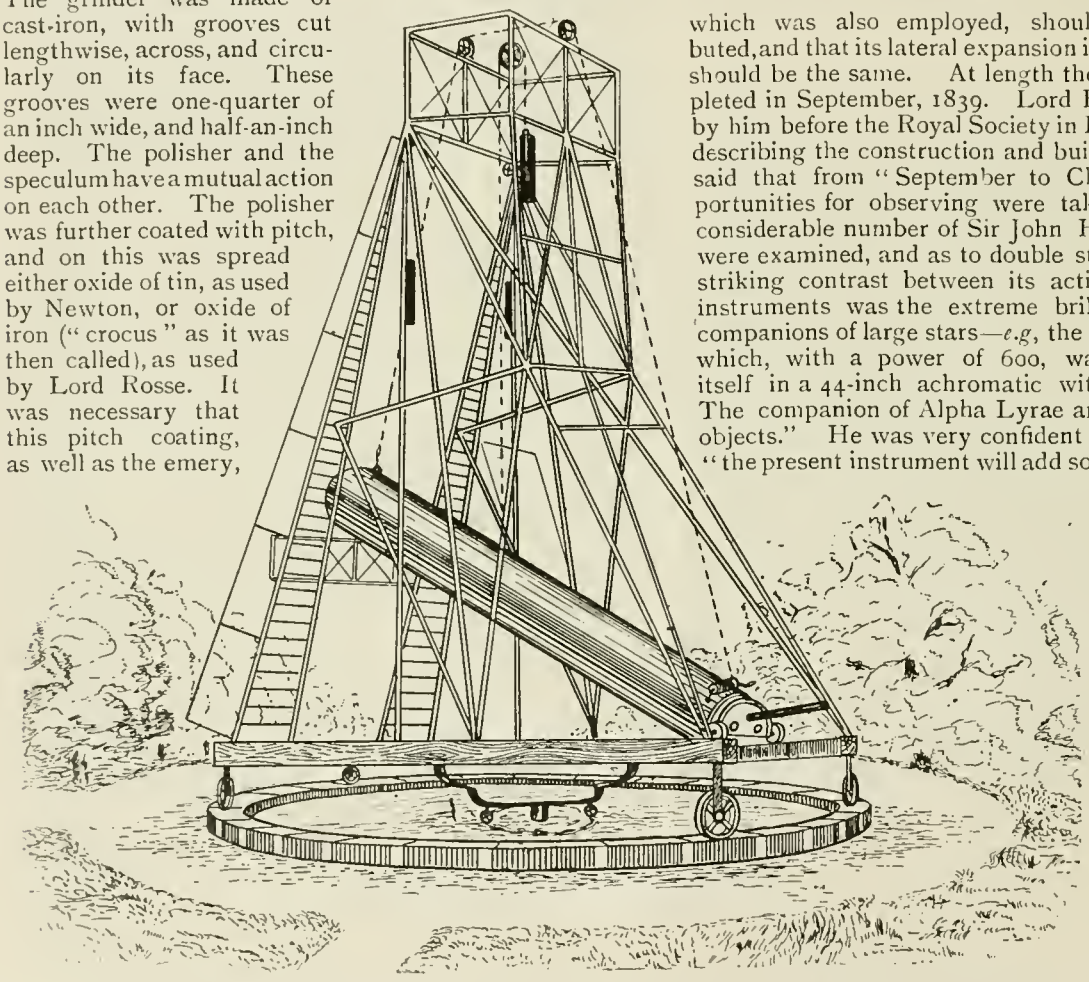
By THE REV. J. T. W. CLARIDGE, M.A., F.R.A.S.

THE knowledge of the existence of the far-famed Lord Rosse's 6 ft. Reflector and its achievements comes to the vast majority of the public from magazine sketches and photographs; but few, comparatively speaking, are aware even of the existence, or of the important and delicate work accomplished by the 3 ft. Reflector, as seen in the photograph which we here exhibit. These wonderful instruments may be mentally pictured and conjectures entertained as to their actual appearance and situation, but those who have never seen these great and powerful searchers of the heavens can form no idea of the quietude and loveliness of their surroundings. On one side is a large lake bordered with trees and covered with water-lilies, its still surface only disturbed by numerous wild-duck and other water-fowl. On the other is the majestic castle with its lawns and terraces, merely a stone's throw from the world-renowned telescopes. The builder of these, William Parsons, third Earl of Rosse, and father of the present Earl, was born at York, June 17th, 1800. He succeeded to the title and estates in 1841. It was as far back as 1827 that his scientific mind encouraged him to experiment on the improvement of the reflecting telescope (for he had no experience whatever in the construction of the refractor), and to this object the whole of his attention was directed.

Sir Wm. Herschel was the first to construct a reflector on a large scale, but he was not altogether so very successful, though he made specula—one of 18 in. diameter, and one of 4 feet—for his 40 feet telescope. Unfortunately he never left any written account of his methods. Consequently Lord Rosse had very little assistance to guide him onwards to the goal of success which he ultimately reached. To grind a speculum of only 6 or 8 inches in diameter in those bygone days was a work of no ordinary labour and skill, and such a one was then considered of great size. A gentleman of the name of Ramage possessed a reflector of 15 in. diameter, and a focal length of 25 feet, and this was for a long time the largest actually in use, for, although Sir W. Herschel's was much larger, it appears that he very seldom used it. Notwithstanding the difficulties that confronted him, added to the apparently small successes of his predecessors, the indefatigable nobleman, endowed as he was with such remarkable mechanical and mathematical skill, untiring patience, and a dogged perseverance, set about his arduous work with a zeal that by-and-by crowned all his efforts with triumph. After many trials as to what combination of metals was the most advantageous for specula, as regards their whiteness, porosity, and hardness, he discovered that copper and tin when united in their atomic proportions—viz., copper 126·4 parts to tin 58·9 parts—was the best. This compound is of a brilliant lustre and hardness, yet very brittle, and with a specific gravity of 8·8 was found to be freer from pores than any other with which he was acquainted. Having thus ascertained the desired proportions, he set about casting the speculum. The difficulties attending this process were such that, instead of having the reflector, which was to be 3 feet in diameter, in one piece (which was subsequently done), he tried the expedient of casting it in 16 separate portions. When cast, these pieces were fixed on a bed of zinc and copper, mixed in the proportion of 2·75 of the latter to 1 of the former, a species of brass which readily expanded in the same degree as the speculum metal. The several pieces were then ground as one body to a true surface, and when soldered and polished were

considered highly satisfactory. Great difficulties were experienced in the casting in the sand, and extreme care in the cooling period of 6 days was required. As it was, several large castings were cracked. However, by using hoop iron at the bottom of the mould he was enabled by this to allow the gas developed to escape, thereby freeing the speculum from pores and air-bubbles. After the 6 days' cooling the disc was ready for further development. It was about $3\frac{3}{4}$ inches thick, and weighed 13 cwts. The metal for it was placed in 2 cast-iron crucibles and melted by turf fires, as these were considered steadier than those produced by coke. Before the speculum was polished it was worked to a spherical figure by the grinding process. A steam engine of 3-horse power was the one employed for this purpose. The grinder was made of cast-iron, with grooves cut lengthwise, across, and circularly on its face. These grooves were one-quarter of an inch wide, and half-an-inch deep. The polisher and the speculum have a mutual action on each other. The polisher was further coated with pitch, and on this was spread either oxide of tin, as used by Newton, or oxide of iron ("crocus" as it was then called), as used by Lord Rosse. It was necessary that this pitch coating, as well as the emery, which was also employed, should be evenly distributed, and that its lateral expansion in the grinding process should be the same. At length the telescope was completed in September, 1839. Lord Rosse, in a paper read by him before the Royal Society in London, in June, 1840, describing the construction and building of the telescope, said that from "September to Christmas, 1839, all opportunities for observing were taken advantage of. A considerable number of Sir John Herschel's test objects were examined, and as to double stars, perhaps the most striking contrast between its action and that of other instruments was the extreme brilliancy of the minute companions of large stars—*e.g*, the companion of Polaris, which, with a power of 600, was very like Polaris itself in a 44-inch achromatic with a $2\frac{3}{4}$-inch objective. The companion of Alpha Lyrae and Rigel were brilliant objects." He was very confident that as to the Nebulæ "the present instrument will add something to our present knowledge." "I think I may say," he continued, "that the Nebulæ 27 Messier, the Annular in Lyra, and, what, perhaps, is more curious, the edge of the great Andromeda, have shown evident symptoms of resolvability. Clusters were examined and drawings were made. My friends were delighted when they examined the Crab Nebula." The powers used were 600, 800, and 1,000. The instrument





The Machinery of the Telescope with the 3 ft. Speculum as it appeared in 1839.

acted very powerfully on the lunar surface, and showed a variety of details not marked in Beer and Madler's map.

The accompanying sketch which is a copy of the one made by Dr. Woods, a physician, 60 years ago at Parsonstown (now called Birr), shows the original instrument with its machinery. The tube is 26 feet long, and the whole is supported on 4 wheels running on the iron circle. The pivot on which it turns, the wheel and axle for raising or lowering the instrument, the counterpoises, and the observer's gallery will be easily recognized. It certainly was then regarded as the finest instrument in the world, until it was surpassed and thrown into comparative insignificance by the mighty 6 feet speculum, erected close by, and which remains to this day the largest of its kind. This was completed in 1842. It was very pleasing to note that the whole of the machinery, buildings, and everything connected with both of these instruments was done by local artisans and under the immediate superintendence of the great astronomer, who died October 31st, 1867. Looking at the original and the modern 3 feet telescope, we see that many alterations and improvements have been made. Under the present Earl it wears an entirely different aspect to that which it wore in that memorable month of September, 1839. Of late years it has been employed very largely for planetary observations. From 1851 to 1886 the planet Jupiter especially was the object upon which a great amount of attention was bestowed. When it was first completed it was mounted as a Newtonian on an altazimuth stand, but as that was not altogether suitable for observations requiring absolute accuracy, it was afterwards mounted equatorially, which renders it adapted for photographic and spectroscopic work. Here it may be observed that a most important achievement in astronomical science was made by means of this 3 feet reflector. It was for a long time a debated question among scientists, "Does the earth receive any heat from the Moon?' It was at last decisively settled by the aid of this instrument that lunar heat does enter our atmosphere, though the amount is extremely small, being about one twenty-thousandth part of a degree (Fahr.), and to the labours and observations of the present holder of the title this addition to our scientific knowledge is due. These lunar heat observations are still being pursued.

Such is a brief account of the history of this remarkable instrument, and though not to be compared with its powerful 6 feet neighbour, still it has rendered, and will do so under the present skilful management and direction, ever-increasing help in research into the vast domains of the Universe.

Who's Who for 1907.—We have received a copy of *Who's Who* for 1907 (A. and C. Black; 10s. 6d.), which has been revised, corrected, and considerably augmented. It is so entirely trustworthy and complete a book of reference that it inspires one with a feeling of wonder as to what the world's workers did without it in the years prior to its publication. It now numbers 2,000 pages and more than ten times that number of biographies. No praise could be too high for its thoroughness and completeness.

Who's Who Year Book, published by the same publishers at the price of a shilling, supplements the larger volume with a valuable collection, in tabular form, of scientific, official Parliamentary, social, university, and artistic information. It is a compressed directory.

A New Volcanic Island.

The Third Bogoslof.

SOME weeks after the Californian earthquake, the officers and crew of the U.S. Fish Commission Steamer *Albatross*, while on their way, under Captain L. M. Garrett, to investigate, with Professor Charles H. Gilbert, the fisheries of Japan, passed the group of islands known as the Bogoslofs, and to their astonishment, perceived that a third island had been added to the other two. Professor Gilbert, in a personal letter concerning the first sight of the island, on May 28, writes:—

When I saw the Bogoslofs in 1890 there were really two small islands about 1½ miles apart, one of them steaming and the other cooled off. [As will presently appear, all three of the islands were of volcanic origin, one having arisen more than a century, and the other twenty-three years, ago.] This has been the condition for a number of years, so the hot one had received the name of Fire Island, the cold one, Castle Island. When they came in sight yesterday, we were astonished to find that Fire Island was no longer smoking, and that a very large third island had arisen half-way between the other two. It was made of jagged, rugged lava, and was giving off clouds of steam and smoke from any number of little craters scattered all over it. Around these craters, the rocks were all crusted with yellow sulphur.

In a later letter, written from Yokohama, Dr. Gilbert said:—

I wrote you a full account of Bogoslof, but the letter seems to have miscarried. Our discovery seems to have been corroborated later by some revenue cutter, but if the newspaper report agrees with their findings, very extensive changes took place in the interval between the two visits. When seen by us, the new cone, occupying much of the space between the two older ones, was somewhat higher than either, but was certainly far from 900 feet high—300 feet would be an extreme figure. There was no evidence of a central crater. The steam and fumes were given off most abundantly from cracks and fumaroles on the slopes. About these were heavy incrustations of sulphur. We saw no indications of boiling water, nor did we believe that landing would be impossible.

As we have said in parenthesis, all three of the Bogoslofs, which are about 120 miles south of the Pribyloff Seal Islands, have risen from the sea, hot and steaming, in historic times. The Pribyloff Islands, as Professor Starr Jordan remarks in an article on the Bogoslofs, in the *Popular Science Monthly* (New York), had an origin similar to that of the Bogoslofs. That they are of volcanic origin, their composition leaves no room for doubt. Of the older Bogoslofs, one of which has for twenty years been known as New Bogoslof, Dr. Grove Gilbert, writing seven years ago, and noting the rapid disintegration of the islands, predicted that in this century the name Bogoslof would attach only to a reef or shoal, were it not for the possibility of new eruptions.

It may be noted as a curious example of scientific prescience that Dr. Gilbert went on to say:—"The pulse of the volcano is so slow that we have noted only two beats in more than a century, but such sluggishness must not be taken as a symptom of death, or even decline, for volcanic organisms are characteristically spasmodic in their activity. Long before the sea has established its perfect sway the arteries of the mountain may again be opened and a new and larger island put forth to contest its supremacy." The pulse of the volcano has certainly quickened, and the floor of the Behring Sea in this region seems to be still unsettled,

Old Bogoslof, or Castle Island.
(From "The Popular Science Monthly," New York.)

Bogoslof of May, 1906. From New Bogoslof, or Fire Island.
(From "The Popular Science Monthly," New York.)

The Three Bogoslofs, May, 1906.
(From "The Popular Science Monthly," New York.)

so that astonishing changes may be looked for at any time.

The oldest Bogoslof, now called Castle Island, rose from the sea in 1796; and Kotzebue describes the first glimpse of it, as seen by a trader, named Krinkof, who had been forced to seek refuge from a storm in a neighbouring island. The birth of the volcanic islet was accompanied by an earthquake which shook the island where the traders had taken refuge, and by an outburst of fire with thunderous explosions. The island was said to emit fire for months afterwards, and for eight years afterwards the water round it was warm and its ashes unbearably hot. The eruption of 1883, in which the second Bogoslof, called Fire Island, was born, had no witnesses; but in September of that year great volumes of steam and smoke, accompanied by showers of ashes, were thrown out from the summit and through fissures in the sides and base, the bright reflections from the heated interior being visible at night. At the time of this eruption a severe earthquake was felt in the sea off Cape Mendocino, apparently in the line of the Portolá-Tomales rift, of April, 1906.

The islands were visited in 1884 by the officers of the U.S. Revenue Cutter *Corwin*, and Lieutenant J. C. Cantwell and Surgeon H. W. Yemans made the ascent of New Bogoslof. Lieutenant Cantwell thus describes his experience in the "Cruise of the *Corwin*":—

> The sides of New Bogoslof rise with a gentle slope to the crater. The ascent at first appears easy, but a thin layer of ashes, formed into a crust by the action of rain and moisture, is not strong enough to sustain a man's weight. At every step my feet crushed through the outer covering and I sank at first ankle deep, and later on knee deep, into a soft, almost impalpable dust, which arose in clouds and nearly suffocated me. As the summit was reached the heat of the ashes became unbearable. . . On all sides of the cone there are openings through which steam escaped with more or less energy.

Seven years after that, Drs. Merriam and Mendenhall, of the Behring Sea Seal Commission, found the newer island still smoking, steaming, and occasionally roaring like a giant steam escape. The older island had quite cooled, and had become a sheer cliff or hill of cold ashes, and was, and is, the home of countless sea birds, as well as of a small herd of sea lions. Captain Cook, in the eighteenth century, had passed by the neighbourhood of this island. This was eighteen years, however, before it was born, and he named a pillar of ash or rock which he found there Ship Rock. Ship Rock fell in ruins five years after the birth of Fire Island.

The question which naturally arises is whether the rise of the newest Bogoslof was directly connected with the Californian earthquake. The possibility, remark Professor Starr Jordan and Mr. Archibald Clark, in the article from which we have quoted, "is heightened by the fact that the

great earthquake rift, which extends through the coast range of California, for a distance of 200 miles, follows a direction, which, if produced northward to Behring Sea, would pass near the islands of Bogoslof. Again, this earthquake rift was largest, and its effects more violent, where it entered the sea in Mendocino County than at any other point throughout its course, the extent of the lateral movement along the crack increasing from about two feet in Monterey County, to about 16½ feet at Point Arena, where it finally enters the sea.

"In opposition to this view may be placed the improbability that an earthquake rift or fault would extend so far as from the centre of California to Behring Sea, a distance of more than 2,000 miles, and through such depths of water as intervene between Point Arena and Bogoslof. It is also stated that the evidence of the seismograph, so far as understood, favours the idea that the great earthquake was confined to California, although its centre of disturbance was clearly in the sea in a westerly direction from Cape Mendocino.

"It is evident, also, that the rise of the third Bogoslof was attended by little, if any, disturbance in the immediate vicinity. The advent of each of the other two islands was marked by earthquake shocks, the fall of volcanic ashes, and displays of fire, observed and felt by the people of Iliuliuk, on Unalaska Island. The people of this village in 1906 were unaware of the presence of the new island until the news was brought in by vessels touching at the harbour."

On the whole, the weight of evidence at present seems to favour the idea that the Bogoslof disturbance of 1906 was local in character, and the coincidence in date with the California earthquake involves no actual relation between the two phenomena.

The January Eclipse of the Sun.

IT is truly unfortunate that the total eclipse of 1907 January 13-14, whose totality track has the rare advantage of being entirely on land, should fail so lamentably in other ways as to be practically disregarded in this country. The reasons, or some of them, are not far to seek, for the track commences not far from the Northern extremity of the Caspian Sea, and, curving in the familiar manner of eclipse tracks through E.S.E., E., and E.N.E., finally reaches a point among the south-eastern head waters of the Lena Basin, not far from the Gulf of Okhotsk. Even in mid-summer, a considerable portion of the track over the "roof of the world," is considered inaccessible, but in mid-winter, the occupation of more than a few of the most favourable points is unthinkable. In Western Turkestan, where the line of totality goes nearly a thousand miles further south than London, there would appear to be the best chance of reasonable conditions, but most of the land lies so high in Central Asia that bitter cold is almost a certainty, though in a few sheltered valleys it will be less rigorous. Communication is better than it was a few years ago, for there is direct railway connection with Europe *via* Moscow and Orenburg to Tashkent, and between that Observatory and Samarcand are several stations not far from the central line, of which, perhaps, Jizak is the most accessible. Tsairosu, in Mongolia, is the only station further East than Turkestan that has been suggested for occupation, but the principal expeditions will be Russian, and of these M. Hansky's is sure to be well to the fore. There are expeditions planned from Germany, under the auspices of Dr. Schorr, of Hamburg, and from France, equipped by the Bureau des Longitudes. Many will remember the success that attended the Russians and others at the ill-fated eclipse of 1896, but that was in August. We can only hope that the results on the present occasion will be commensurate with the zeal of those who are braving the unpromising conditions. Doubtless, had an official expedition been sent from England, several enthusiastic amateurs would have been prepared to accompany it if possible, the more so that the chances of success in January 1907, though perhaps not encouraging, are quite as good as, and in many ways better than, those of any other eclipse in the next five years, which will be singularly barren in that respect.

The present eclipse belongs to a series (recurring at the well-known period of 18 years 11 days), whose first member was the celebrated Siege of Paris eclipse of December 1870, when Janssen escaped from Paris in a balloon in order to observe the eclipse in Algiers, and saw nothing of it owing to cloud.

A Perpetual Calendar.

By CHARLES E. BENHAM.

THE practical utility of a simple method whereby, without pencil, paper, or reference table, one is enabled to tell almost in a moment the day of the week for any given date is so great that anyone who has been at the small pains necessary to master the process will never repent of having done so. On the contrary, he will only wonder that a formula so simple and so advantageous is not made a part of the regular curriculum of every elementary school.

At a first glance the system prescribed may seem a little complicated, but with very little practice it becomes perfectly easy and simple, while anyone with a natural talent for mental arithmetic may speedily acquire ability to perform the process with such rapidity that his powers seem, to the uninitiated, little short of magical.

The method depends primarily upon a system of casting out the sevens, that is, dividing by seven and taking only the remainder. Thus, 24, when the sevens are cast out yields 3; 21, 0; 40, 5; and so on.

Bearing this in mind, the process for a perpetual calendar is simply to add together four numbers, representing respectively century, year, month, and day of month, casting the sevens out as the addition proceeds. Thus, if those four numbers were 0, 23, 6, 14, we should add together 0, 2, 6, and 0=8, or, casting out the sevens, 1, which would mean that the date in question was on the first day of the week, or Sunday.

But what we have to arrive at is how to ascertain the four appropriate numbers for a given century, year, month, and day.

The rule is as follows:—

(1) For the Century Numbers.—These must be memorised, 2 for the century 1800-99, 0 for 1900-99, and 6 for 2000-99. These are thus fixed for convenience, because the system being calculated on this basis, the 0 for the present century, which is most likely to be wanted, will save calculation. This arrangement is a modification, by Mr. Robert Cook, of Chelmsford, of Howard's Perpetual Calendar, in which the 0 was fixed for the previous century.

(2) For the Year.—Cast out the sevens from the last two figures of the year and add the quotient of the same figures divided by four, neglecting fractions. Thus, for 1860, the number is 4 + 15 = 19, or, casting out the sevens, 5. For 1906 it is 0, for 1840 it is 5 + 10, or, casting out the sevens, 1.

(3) For the Month Numbers.—These must be memorised as follows:—

Jan.	Feb.	Mar.	April	May	June
1	4	4	0	2	5
July	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
0	3	6	1	4	6

For leap years, January is 0, February 3, the others being unaltered.

(4) For the Day Number.—This is simply the number of the day of the month, casting out the sevens if necessary. Thus, the 3rd is 3, the 25th is 4, the 31st is 3, and the 28th is 0.

Examples of the application of these rules:—

Given such a date as April 15, 1860.

The century number is	...	2
The year number is ...	...	5
		7
Casting out the sevens ...	...	0
The month number is ...	...	0
The day number (casting out 7's)		1
Total ...		1

The day is, therefore, Sunday.

January 13, 1904.

Century number	...	0
Year number ...	...	5
Month number (leap year)		0
Day number, 13 (casting out the sevens)	...	6
Total ...		11 or casting out the sevens, 4.

The day is, therefore, Wednesday.

When the process is carried out mentally, it will be immediately seen in practice that the casting out the sevens as the addition proceeds, does not encumber, but simplifies the operation, as it reduces the addition to small numbers, and the calculation is soon performed with surprising rapidity.

With regard to leap year, it must be borne in mind that at the even centuries there is no leap year unless divisible by 400. Thus, 1900 is not leap year, nor 1800, but 2000 is.

THE SUGGESTED BOOK CLUB.

So very few applications have been received for membership of the proposed Scientific Book Club, that we much regret to say it will be impossible to proceed with it. Had only a few hundred applied we might have started the library, even at a loss, but, as it is, the numbers are such as to show that there is practically no demand for such an institution. The books already purchased will be sold off, and a priced list of them will appear in our next issue.

White Ants.

By E. H. SCAMMELL, F.C.I.S.

THERE has been considerable diversity of opinion as to what distinct family the insects commonly known as White Ants, otherwise Termites, belong. In some respects they resemble one of the principal insect divisions, and in other respects a second. Recently, however, they have been placed by some authorities by themselves in an order known as "Isoptera." The name "White Ants" is somewhat misleading and incorrect, for they differ widely from true ants, and only in some cases are they white. At present there are some 300 distinct species known to entomologists, though there are probably many more. They are found only in warm climates, and, with very few exceptions, are entirely vegetarian in their diet. The basis of their food is woody matter. Certain varieties, however, cultivate, in their termitaria or nests, a peculiar form of fungus upon which they feed; others for the same purpose cut and store up grasses. Termites are particularly cleanly, and consume their dead and any other objectionable matter which is in their way. They also themselves prepare a peculiar kind of food, of earth, grass, and a salivic deposit from their own bodies. Their chief diet, however, is wood. They usually prefer soft woods such as European deal, but there is scarcely any wood which can be regarded as entirely proof against their voracity. Even the well-known West Australian jarrah is attacked by them, although they prefer other kinds of timber. It may be here noted that the comparative immunity jarrah enjoys largely depends upon the ground upon which it is grown, that grown in the ironstone ranges being more immune than the same wood from other parts of the State.

Termites are gregarious insects. They live in families or colonies and appear to be governed by laws and to work systematically. Different varieties construct totally different kinds of dwellings. Some take up their abode in trunks of trees, while others construct mounds, rising in some cases as high as 18 feet, a third variety dwelling in subterranean passages, burrowed in the ground, or simply living in decayed pieces of wood. The number of individuals in a colony may run from a few hundreds to hundreds of thousands. In most varieties the inhabitants of a colony are usually confined to the offspring of one Royal pair, although in nearly all nests there are to be found complementary and supplementary royal individuals. Unlike other social insects where there is a marked difference between the males and females, and where the workers are of the female sex, as is the case in bees, in Termites the males and females are closely similar, and the castes are in no way correlative with sex. The following kinds of adults are usually present in a colony, viz:—

1. Workers.
2. Soldiers.
3. Winged individuals, known as imagos or nymphs, ready to leave the nest.
4. King and Queen.
5. Complementary and Supplementary Royal individuals.

These, according to their relative condition of development, may be further divided until as many as eleven or more distinct varieties are found in one colony.

The workers, which are usually blind, have no trace of wings except in some instances where there are slight stumps. As their name indicates, they are generally the food-winners, and their duties comprise the

building of the nests, tending the eggs of the queen, and providing nourishment for the young larvæ. In some species they are also effective combatants, though they possess no special structures for this purpose.

The second class, the soldiers, which includes both sexes, forms from one to twenty per cent. of the inhabitants of a colony, and is, perhaps, the most remarkable feature of termitid biology. As a rule a marked difference exists between those of the various species, which, consequently, can be distinguished by their soldiers more readily than in any other way. There are two very distinct kinds, those having enormous flat heads and very large mandibles, and those whose heads are of a more natural size, but are armed with a kind of horn between where the eyes should be. These latter, from their appearance, may be termed a sort of unicorn variety. Apparently there is no species with both these characteristics. The soldiers in nearly every instance are totally blind and wingless. The large-headed variety, at the approach of danger, engage in a threatening display in order to frighten their enemies, making a rhythmic noise by hammering the ground with their heads. They also attack vigorously. The unicorn emits a kind of viscous fluid from his horn with which he dabs his adversary.

The winged termites or nymphs, which can see, are attracted by artificial light when the swarming season is on, as is well-known to all who live in tropical countries. In more temperate climates, such as Southern Europe, the winged forms appear in early summer, while in equatorial regions they emerge for the most part in simultaneous swarms at favourable seasons, although in some species they seem to be constantly produced in small numbers all the year round. The object of this swarming appears to be propagation. It has been noted that all those going from a nest at one time are of one sex. The wings are so constructed that they can be shed at any moment. These winged termites are the favourite food of many insects, such as the common ant. Birds also and a large number of smaller animals eat them ravenously. In some cases, notably in parts of India and West Africa, they are used for human food, and it is stated that they are digestible and delicate in flavour.

Although millions of these insects fly abroad during the swarming season, few survive the attacks which are made upon them by their enemies. When a couple pair off they shed their wings and then start to make a new colony, becoming the King and Queen, or they may be taken possession of by an orphaned colony and elected to the vacant throne. The position of the Royal pair is not always an enviable one, for, although in some instances they appear to have their entire liberty and can come and go as they please, in others they are prisoners for life, their cell being usually about the centre of the termitarium or in a part of the nest least open to attack. They are waited on by the workers, who are most careful to attend to their wants. The sole duty of the Queen, who is nearly always found in a gravid condition, appears to be the laying of many thousands of eggs in the course of a season. As she lays them they are taken hold of by the workers and carried to a more or less distant part of the nest. It has been stated by some that the difference in the various castes and classes can be distinguished in the eggs, but more recent authorities have affirmed that this is not so, and that probably the workers and soldiers, as well as some of the other varieties are kept in a state of arrested development by differential feeding.

In the event of accident to the King or Queen, a complementary or, failing any of this variety, a supplementary Royal individual is raised to the throne. In some cases several of the required sex may be promoted. These neoteinic forms, while never becoming true kings or queens, are yet able to produce eggs and so to continue the race. The difference between the King and Queen and their offspring is in most cases so marked that it appears strange that the latter should have come from the eggs of this one pair.

The termitaria in which certain varieties of these creatures dwell are built up of carefully-digested portions of earth and vegetable matter coated with a liquid, emitted by the workers, which forms a hard cement, so that it is possible to walk over these mounds as though they were solid.

All termites require a certain amount of moisture, some more and some less, as without this they die very quickly. Certain species bore into growing trees, others again make their nests upon the branches, using the living wood as food, but the majority of those who do not build termitaria take up their abode in decayed pieces of wood or that which has been cut down for some time, and which, while not exactly wet, contains sufficient moisture for their purpose.

If white ants confined their attention to decayed or rotten wood there would be little need to take steps towards preventing their encroachments, but, unfortunately, they also attack the woodwork of buildings, and when once inside it is difficult and in some cases impossible, to dislodge them.

Their method is insidious, for they make merely a slight puncture in the outside of the wood, while they entirely eat out the interior, leaving only a thin crust. Joists which were apparently sound, and floors which appeared to be quite intact, have been known to suddenly give way, to say nothing of the breaking-up of tables and chairs owing to the attacks of these insects.

Various attempts have been made from time to time to deal with this scourge of the tropics, with, however, only partial success. The immunity which some woods enjoy seems to depend largely upon the variety of termite to whose depredations they happen to be exposed. Most kinds prefer soft piney woods, while some others again seem to dislike them, though they will readily attack other timbers. It has been found to be quite useless to paint or cover wood with even a poisonous admixture, as termites are able to even penetrate iron, glass, or mortar to get at the wood underneath. This is usually accomplished by the emission of the viscid secretion used by the workers for cementing the walls of their termitaria or subterranean passages, this secretion acting as a corrosive.

Recent researches into the methods and habits of these insects have proved most conclusively that the only way to prevent the destruction of timber is by thorough impregnation with some objectionable or poisonous substance, and this view is the more emphasised as the opinion held by travellers and some residents in tropical countries that if the Queen could be discovered and killed the workers would disperse, has now been found to be a fallacy, owing to the presence in the colony of neoteinic forms, which, after a short time are able to take the place of the deceased Royal individuals.

Creosote and similar mineral oils have been tried, but these, while successful up to a certain point, are on account of their smell and for other reasons, among which may be mentioned their high inflammability, useless for the timbers of dwelling-houses or for furniture.

After a large number of experiments, the Powell Wood Process Syndicate, Ltd., of 28, Fleet Street, London, E.C., claim to have at last solved the problem. By the Powell process the wood is boiled in a saccharine solution to which is added certain substances obnoxious to termites, though they are otherwise perfectly inodorous and innocuous. In the subsequent cooling the solution is absorbed by the tissues of the wood, with the result that the wood is not only strengthened and improved in quality, owing to the pre-

sence of saccharine matter, but is also proof against both insects and fungoid growth. Wood thus treated has been buried in ants' nests and placed in various positions open to attack, but in every case it has enjoyed complete immunity, while untreated pieces of the same wood, either attached to the processed specimens or placed around it, have been consumed.

The news of this discovery will be received with acclamation in many parts of the world, as it will enable local timbers to be employed for constructional and other work, especially as the process will effectually season the wood within a few days of its being cut down.

The Pleiades.

THIS photograph, taken by Prof. Max Wolf in 1902, shows the arrangement of stars in the Pleiades with the curious light inner nebulæ. The discovery of the nebulous formation, which seems to extend to the whole group, "ranks" (according to Miss Clerke) "among the most important achievements of celestial photography."

The photograph was taken with the 16-inch Bruce telescope at Heidelberg, with an exposure of five hours. It has been enlarged from the original negative $3\frac{1}{4}$ times, and has not been re-touched.

Next month will be commenced a series of articles on "Aërodynamics and the Theory of the Aëroplane," by Major Baden-Powell, which should prove of interest at the present time.

SCIENCE YEAR BOOK.

ONE of the star maps in the first issue of the Science Year Book was wrongly printed, the blue portion not corresponding with the black. In the later edition this has been rectified, but any purchaser having a copy with the inaccurate chart, and who will apply to the office, will be supplied with a fresh page to replace it.

Photography.

Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

The Induction Period.

IT has been known for about a hundred years that if a moist mixture of chlorine and hydrogen is exposed to light the two gases combine to form hydrochloric acid, explosively if the light is very bright, such as sunshine, or quietly and gradually if the light is more subdued. It is just about fifty years ago that Bunsen and Roscoe used such a mixture of gases to discover how the amount of chemical change produced in it was affected by variations in the acting light. But when light falls upon such a mixture, the change does not start at once, and it may be a few seconds up to even a few hours before the maximum rate of change that a given light can produce is attained. Or, in other words, the mixture of gases appears at first to be quite insensitive, and when the action begins, it gradually increases its sensitiveness. This "induction period" has been ascribed to a resistance to combination inherent in one or both of the gases, or in some other way to a change that must precede combination to make it possible. It has been suggested that this change might be either of a chemical or of a merely physical character.

Recent investigation by Messrs. C. H. Burgess and D. L. Chapman shows that this "induction period" is sometimes, and probably always, due to some impurity that the chlorine acts upon more readily than upon the hydrogen, or that in some other way prevents the combination of the chlorine and hydrogen. These investigators state that "no evidence can be obtained of a period of photo-chemical induction with a moist mixture of chlorine and hydrogen in the absence of impurities. . . ." Therefore it appears that all arguments founded on the supposed existence of this "induction period," and the analogies that have been drawn from it, fall to the ground. It would be possible to found certain arguments on its non-existence as to the nature of the developable image, but I do not think that they would have any value, as there is no proof that the two cases are analogous.

The Mechanical Action of Light.

The *British Journal of Photography* (p. 970) gives an account of a paper by F. Alefeld, in the *Chemiker Zeitung*, in which he describes how he has obtained results that appear to indicate that when solutions of certain substances are evaporated so as to form a film, dried at 100° C. for 15 to 30 minutes, and then exposed under a negative for about half an hour to bright sunshine, the substance so moves about that it accumulates where subjected to light at the expense of those parts that are shielded from the light. The thio-resinates are generally used in an appropriate solvent (water solutions will not work so well), choosing one that leaves on ignition an oxide that will colour glass. The exposed film is then heated sufficiently to cause the oxide to combine with the glass. Sharp pictures are so produced, but the whites are never pure, *i.e.*, the substance never completely leaves the parts shielded from light. A second exposure under another negative does not obliterate the effect of the first exposure, perhaps

The Pleiades.

(Photo taken by Professor Max Wolf.)

because the film has become more dry or set, or the light may cause a chemical change in the material and so tend to retard the further migration of the compound. To confirm the results, a compound of silver was used, applying it to gelatine films which were then shielded in alternate strips and exposed. The silver was estimated in the exposed and unexposed strips, and the former contained sometimes twice as much as the latter.

The moving about of a substance that is free to move is very familiar in crystallisation; the spaces between the crystals being nearly, if not quite, free from the substance, while at first it was evenly distributed through the solution or space it occupied. It has often been observed that light appears to facilitate or encourage the deposition of a solid, though it has been stated, without, perhaps, sufficient evidence, that the effect is due to the shaded part being of slightly higher temperature than the other. The experiments referred to above appear to support the idea that light itself is really effective.

Talbot's Law. The rotating disc with differently coloured sectors is so often used in colour photometry for photographic purposes, that the accuracy of this method of work is a matter of prime importance. So far as visual work in concerned, it depends upon Talbot's law, which states that "if any part of the retina be excited by intermittent light recurring regularly in the same way, then, if the period be sufficiently short, a continuous impression will result, which is the same as that which would be produced if the total light were distributed uniformly throughout the whole period." It is satisfactory to know that investigations by Mr. E. P. Hyde, which he described before the American Physical Society last April, show that this law is correct for white, red, green, and blue light for angular openings from 10° to 288°, within a possible error of .3 per cent., though the deviations from the law may be a little greater in the case of the coloured lights than white light. Therefore the doubts that have from time to time been cast upon the accuracy of this method appear to be without foundation.

Still Development. I use the word "still" here as the anthithesis of "rocked," the developing solution not being moved over the surface of the plate. This method of development has recently been described and eulogised as if it were new, but it is really quite old and the effect of it has long been well known. It may be carried out in more ways than one. The plate may be allowed to lie at the bottom of the developer, which is preferably made rather weaker than usual, though not too weak, or the mixing of the various parts of the solution by diffusion will defeat the very object of the method; or as soon as the plate has absorbed a suitable quantity of the developer it may be removed from the dish so that the only developer that is available is either in the film or on its surface. It is clear that by such treatment the developer available on the most exposed parts will be more quickly exhausted than that on the less exposed parts, and that therefore the growth of the image will slacken most where the exposure effect has been greatest, and the result will be a flatter (or, to use a more complimentary term, a "more harmonious") negative. Where there is a tendency to hardness, as from under exposure, this method may be useful, but generally it is far better to keep the developer moving so that it may have an equal energy over the whole plate, and the extent of its action may be governed only by the exposure effect.

NOTES.

ASTRONOMICAL.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

Photographic Photometry of Coloured Stars.

MR. R. J. WALLACE, at the Yerkes Observatory, has been making further investigations into the suitability of employing colour screens for stellar photography. In the present paper his remarks are more particularly directed to photography with a reflector, so that the chromatic aberration of the instrument itself may be neglected. It is well known that with almost all kinds of photographic plates there are certain portions of the spectrum to which the plates are less sensitive than others. So long as the star groups being photographed are all of the same type of spectrum, then any kind of plate will give a true rendering of their relative brightnesses. In reality, we know that in any star field there are many types of stars, and to obtain a true photographic record of their magnitude we must adapt a colour screen in front of the photographic plate which will reduce the intensity of that kind of transmitted light to which the plate is specially sensitive, so that it may record the true colour values of the object. The dyes Tartrazine, Auramine O, Metanil Yellow S, and Nitrosodimethylanilin were found to be most suitable, and the requisite amounts were incorporated in gelatine solutions and flowed on prepared glass plates. In the case of compound filters, it was found preferable to coat several plates with only one colour each, and then to bind the plates together. The performance of the filter is accurately examined by means of a delicate spectrophotometer, and alterations made until it is exactly adapted to the photographic plate to be employed. Reproductions are shown of photographs of the region surrounding the coloured star U Cygni (which is classified by Chandler in his colour scale as 9.3, where 0 = white), first on ordinary Seed 27 plates, and then on Cramer isochromatic provided with the proper colour filter. The difference is very great, and emphasises the danger of determining any star magnitudes from photographic records unless there has been such control over the colour selection of the plate.—(*Astrophysical Journal* 24, November, 1906.)

Thunderstorms and Sunspot Frequency.

A considerable amount of discussion has been published in the endeavour to prove the existence of direct correspondence between the occurrence of large thunderstorms and the state of the solar activity as evidenced by the epoch of sunspot frequency. Quite recently Dr. A. S. Steen examined the data from a large number of stations in Norway, Sweden, and Denmark obtained during the period 1873-1903. He concludes that the epochs of maxima and minima of thunderstorms occur at or near the epochs of maxima or minima of sunspot frequency. In addition to the main period of eleven years, a subsidiary period of about 5.5 years is also indicated.—(*Hann-Band der Meteorologischen Zeitschrift.*)

Dealing with the same subject, Mr. A. Hutt announced at a meeting of the British Astronomical Association that on almost every occasion in his experience on which there had been a thunderstorm, a new spot had broken out on the sun on that or the next day, or that one of the already existing spots had greatly increased in magnitude. An instance of this occurred on May 13, 1906.—(*Journal Brit. Ast. Assoc.* 17, November 22, 1906.)

Echo of the Valparaiso Earthquake.

The seismograph records of the stations along the Pacific Coast of the Asiatic Continent are of special interest when they occur in connection with the convulsions along the

western mountain ranges in North and South America. From a China Weather Service Circular issued from the Zi-Ka-Wei Observatory, near Shanghai, we learn that the Valparaiso earthquake was registered quite distinctly. The first movements or preliminary tremors of the instrument began on the Friday morning at 8h. 19m. 24s. a.m., China Coast time. As Valparaiso, at the mouth of Santiago Chile river, is nearly at the Antipodes of Shanghai, the distance in a straight line across the earth is about 12,715 kilometres. Giving to the vibrations an estimated velocity of ten kilometres per second, the earthquake must have begun 21m. 12s. sooner at the place of the disaster, viz., at 7h. 58m. 12s. a.m. on the 17th, China Coast time, or at 6h. 58m. p.m. on Thursday 16th, *i.e.*, 13 hours sooner, by the time of the 7 hours zone west of Greenwich. There may be some difference in this estimate if the zone time is not employed in Chile. As an indication of the severity of the shock it may be noted that the waves registered at Zi-Ka-Wei, almost at the other end of the earth's diameter, exceeded 2.7 mm. in amplitude. The end of the disturbance took place at 11h. 19m. a.m.

Chromospheric and Sunspot Spectra.

Observing with the large spectroscope and telescope at Princeton, U.S.A., W. M. Mitchell has been able to obtain a new series of determinations of the lines characteristic of sunspots and of the chromosphere. Comparing these with his first series, it was found that the selections of *widened* lines of the spot spectra during the two periods were so similar that it was unnecessary to publish a new list. In the cases of reversed and weakened lines, however, this constancy does not hold, many new lines of both classes being detected, and a list of these is given, as well as a table of the lines seen bright in the spectrum of the sun's limb, between the wave-lengths 4876.59 and 6883.33, showing their origins and intensities. Considering these facts in relation to phenomena which have been observed in experimental laboratory research, it is pointed out that the presence of hydrogen in the chromosphere may cause certain lines to be suppressed to such an extent that they become invisible against the background of the sky. This is in agreement with the observations of Fowler, that the high-level chromospheric lines are *enhanced* lines, since it is probable that the proportion of hydrogen is greatest high up in the chromospheric stratum. Lower down in the reversing layer other lines gradually make their appearance. In these high-level gases the emission co-efficient would be greater than that of the lines caused by gases at the lower levels; therefore, the absorption of the lines would be less, and, in consequence, across the dark umbra of the sunspot such lines would have an enfeebled or weakened intensity.—(*Astrophysical Journal* 24, pp. 78-94, September, 1906.)

Brilliancy of Mira Ceti.

The well-known variable star o Ceti, or Mira, as it is usually called, is now a very prominent object in the south-eastern sky at sunset. Attention has been drawn to its appearance this maximum in that it has attained to considerably greater brightness than is usual. It is to be hoped that all who have spectroscopic means of observation will obtain records as often as possible. The spectrum of the star is very interesting, and to some extent peculiar; it resembles α Orionis (Betelgeuse) with respect to the dark lines and bands or flutings, but, in addition, there are bright hydrogen lines, which appear to fade out as the star becomes fainter. There is no direct resemblance to the spectra of new stars, so that in this case the eclipse theory is supposed to be a likely explanation of the phenomenon, but the chief difficulty in the way of accepting this is that the lines, both bright and dark, do not show any appreciable evidence of motion.

Peculiar Phenomena of Sunspot Penumbrae.

M. S. Chevalier, writing from the Zo-Sai Observatory in China, calls attention to a peculiar appearance sometimes noticed on the inner edge of the penumbræ of sunspots. This takes the form of a ring of increased brightness immediately surrounding the umbra. It is evident that the phenomenon is not characteristic of all spots, as it has often not been seen when specially looked for. In the paper the author gives a series of photographs of spots showing the bright ring at various stages. In the case of a spot showing this feature it does not appear to vary as the spot crosses the disc, but observations show that the first appearance of it comes out on the north and south of the nucleus, while the spot is entering on the visible hemisphere, then on the east, and finally on the west side. When the spot is approaching the west limb the disappearance begins with the east side, then the west, and finally the north and south. It is probable that sunspots having a regular outline present the phenomenon with the more marked brilliancy.—(*Astrophysical Journal* 24, November, 1906.)

Calorific Emission of the Sun.

MM. Féry and Millochau, continuing their observations with the eyepiece thermopile, give further values of the probable absolute temperature of the solar disc. These are 5,888° and 5,963°, with a possible error of ± 15°. Experiments were also undertaken to determine the variation of emission of several substances at high temperatures, including nickel oxide, magnesia, and platinum.—(*Comptes Rendus* 143, November 12, 1906.)

BOTANICAL.

By G. MASSEE.

Origin of Elementary Species.

PROFESSOR HUGO DE VRIES, whose name is well known in connection with what has been termed "mutation," or the sudden appearance of elementary species in the vegetable kingdom, has recently (*Proc. Amer. Phil. Soc.*) expressed his views in general terms. Darwin's principal conception as to the origin of species was that their gradual evolution depended on the same laws as those that underlie the evolution of races and varieties under culture. This implied time, coupled with much uncertainty, and did not afford the necessary evidence for founding a satisfactory theory. Until quite recently the method adopted for producing new strains was by the slow process of gradual elimination, until the desired strain was obtained in a pure and permanent form. De Vries, on the other hand, maintains that species are not changed into one another, but are permanent, giving off from time to time, sideways as it were, aberrant individuals. Such individuals constitute his mutants or new species, and experiments have proved that, in the main, their characters are constant and hereditary from their first appearance. This is, briefly, De Vries' unit-characters idea, which is the basis of his theory of the origin of species by mutation, which, in turn, leads to the acceptation of saltatory changes, commonly known as sports, as the most probable way employed by Nature to produce new forms. Most of our ordinary agricultural crops are composed of elementary species, and, again, each cultural variety contains numerous sharply-defined types. These types are distinct in botanical characters, and in those properties which decided for or against their utility. By careful searching, the proper type for each special requirement may be perpetuated. The modern method of perpetuating a desirable strain, say, of a cereal, is as follows:—In each thousand plants there are a few phenomenal yielders, and the method of single-seed planting makes it possible to secure these plants, from which new varieties can be made. If these selected plants had been only extreme varietal fluctuations, they would have shown variability and retrogression to mediocrity. As this did not prove to be the case in the experiment quoted, De Vries considers that these phenomenal yielders were, in reality, elementary species, which had remained hidden until rescued by the process of single-seed planting, or, in other words, commencing from the seed of a single individual.

The older, and what may be termed the rule-of-thumb, process for obtaining an improved strain consisted in selecting a number of ears of exceptional size, or possessing in some degree the qualities desired. These were mixed together and sown, and it was only by a long process of elimination, year by year, that the desired result was obtained. The explanation of this is that in all probability several elementary species were included in the first selection of ears, hence the necessarily long period required for eliminating all except the very best elementary species, which, when once obtained, remains permanent. The

method of starting from a single seed obviates the difficulties stated above.

This old-fashioned elimination process of plant breeding has been always considered as the most valuable argument in favour of natural selection; in fact, of late, it was its last remaining botanical support. By means of the modern method of starting with a single factor—single-seed planting—instead of with a quantity of seed, probably containing several elementary and fixed species, all of which but one had to be eliminated, it is considered that this support has now been broken down, and that selection as applied in agriculture is no longer an argument against the conception of an origin of species by saltatory changes.

Vegetation of the Antarctic Sea.

A beginning has been made by C. Skottsberg, who accompanied the Swedish Antarctic Expedition of 1902, in the *Antarctic*, to investigate the marine flora, in order to give a true picture of its nature. Unfortunately, the most important collection of algæ was lost with the ship. The places visited belonging to the Antarctic proper were South Shetland Islands, coasts of Louis-Philippe Peninsula, Palmer Archipelago, Ross Island, and the neighbourhood of Snow Hill. The algal flora proved to be richer than was expected. The salinity and temperature of the sea are important factors, and exercise much influence on the development of marine vegetation. In the Arctic Sea the coast water of Siberia mixes with a large amount of fresh water brought down by the large rivers, and the poverty of the littoral region is considered to be partly due to this fact. In the Antarctic Sea the conditions are different, no rivers are known to exist, and the superfluous precipitation is discharged in the form of icebergs. These are usually carried some considerable distance to the north before they melt. The salinity of Antarctic sea water slightly exceeds that of the Arctic Sea, the temperature of the two is about equal. The temperature sinks and the salinity rises with increasing depth. Ice also, to a great extent, determines the distribution, or even the presence of algæ, which can only grow in places where the beach is free from ice and snow during the summer. During the winter a bank of ice and snow reaches to high-water mark, and a continuation of this in the form of an "ice-foot" covers the greater portion of the littoral region. Perennial algæ live throughout the winter in a frozen condition and deprived of light; the calcareous forms are especially able to endure in this condition throughout the winter, but examples of the more delicate kinds were also collected that had survived this treatment. In some instances very thick ice remains unbroken for seven or eight months in the Dundee Strait, nevertheless, a rich vegetation exists, proving that the Antarctic algæ must possess the power of living for months on the productions of the previous summer. Icebergs and drifting ice also prevent the growth of algæ; in many places both littoral and sublittoral zones are quite polished by icefloes dashed against the rocks by waves or tidal currents.

Owing to the loss of the greater part of the collection, the regional distribution of the marine flora could not be worked out, nevertheless, littoral, sub-littoral, and deep-water zones were found to possess characteristic species. Calcareous algæ are conspicuous in the littoral zone, species of *Iridea* are also in abundance. *Desmarestia* occurs in profusion in the sub-littoral zone, and is as characteristic of the Antarctic as the *Laminaria* formation is for the Arctic. Florideæ are characteristic of the deep-water zone, gigantic specimens of *Gracilaria* (*Leptosarca*) *simplex*, and many other species of smaller size. *Schizoneura quercifolia* occurred in plenty; this species is related to *Delesseria sinnata*, occurring the the Arctic Sea.

CHEMICAL.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

The Poison Ivy.

THE latest addition to our knowledge of the chemistry of this curious plant is that published by Messrs. Acree and Syme in a recent number of the *American Chemical Journal*. The poison ivy or poison oak (*Rhus toxicodendron*) grows in many parts of the United States and in Canada, and in the erect form reaches the height of about 40 inches. When in the vicinity of trees or walls, however, it becomes parasitic, and may then grow to a height of 30 feet or more. For long this climbing variety was regarded as a separate species, but the identity of the poison oak and poison ivy has now been proved beyond question. Both produce small green flowers and small white fruit, and contain a milky juice which turns black on exposure to the air. The leaves are employed commercially in the manufacture of a black varnish stain for boots, being collected between May and July while the plant is in bloom. Another curious property of the juice is that it raises blisters when brought in contact with the skin, while even the vapours given off by the plant, especially by night, have the same effect upon certain peculiarly susceptible people. For this reason the juice was at one time a favoured remedy for certain skin complaints, and is still used to some extent for the purpose in the United States. The poison ivy was introduced into England in 1640, but it was not until 1798 that it was tried as a medicine in Europe, a doctor at Valenciennes being the first

The Poison Ivy *(Rhus toxicodendron).*

to prescribe it to his patients. But long before then the juice of the plant had been recommended as a marking ink. Thus the Abbé Mazeas, in a letter published in the *Transactions of the Royal Society* for 1758, describes his experiments on this point, and states that characters written with the juice upon his linen had remained quite black after constant washing for five years. Incidentally it is mentioned that the plant was then growing in the gardens of the Bishop of London's Palace at Fulham, but inquiries made by the present writer show that it has long since disappeared. Other writers have borne witness to the permanency of the stains produced by the juice upon linen. The writing is quite proof against soap and water, dilute acids, alkalies and bleaching powder, though it is easily removed by ether. The juice is therefore still employed in the manufacture of marking inks in America. Herbivorous animals can eat the poison ivy without ill effects*, but upon dogs it acts as an irritant poison, producing convulsions and death. There are also several cases on record of children being poisoned through eating the berries. One of

*Maisch and Stillé, *National Dispensatory*.

the earliest investigations into the chemistry of the plant was that made in 1858, by K. Littel, who found that it contained a tannin, giving a green coloration with iron salts. He attributed the poisonous action of the juice to the presence of an alkaloid. Soon afterwards, Porcher discovered that the exhalations given off at night by the leaves contained hydrocarbons, which would burn when ignited. Then, in 1865, Dr. Maisch found that the emanations had an acid reaction, and that the leaves contained ammonia but no alkaloid. He isolated a volatile substance, which combined with alkalies to form salts, and to this substance, which he termed *toxicodendric acid*, he attributed the poisonous action of both the juice and the exhalations, for whether in solution or in the form of vapour it produced the same effects upon the skin. This was confirmed in 1883 by Mr. Pettigrew, who found that the acid resembled formic acid in many of its properties. Messrs. Acree and Syme have now separated from the juice a poisonous wax-like substance, which does not volatilize when heated with alcohol vapour. They have also proved that all cases of poisoning can be cured by the use of a solution of potassium permanganate.

Spontaneous Ignition of Carbon Bisulphide.

Carbon bisulphide, a mobile, highly refractive liquid, prepared by passing sulphur vapour over hot carbon, is extremely valuable as a solvent for fats, for killing weevils in grain, and for many other purposes, but serious drawbacks attend its use. The ordinary commercial product has a particularly offensive smell, which is commonly attributed to the presence of traces of impurities. Then the vapour is very poisonous, and workmen who handle the liquid in badly ventilated factories are liable to suffer from depression, coma, and loss of memory. The greatest risk, however, is due to its being highly inflammable, igniting at quite a low temperature, and burning with a blue flame to form carbon dioxide and sulphur dioxide. So great is the inflammability of carbon bisulphide, that numerous instances have been recorded where it has taken fire spontaneously. In a recent case described by M. Pape, the chemical became ignited when being poured through a metal funnel into a glass carboy, in the open air, and far away from any source of flame. The day was very hot and dry, and the immediate cause appears to have been an electric discharge caused by the friction of the liquid falling upon the iron funnel, which was isolated by the glass of the carboy. Other cases of spontaneous ignition have taken place while the bisulphide was being poured into iron drums. An electric discharge has also been looked upon as the chief cause of these accidents, though it has been suggested that the heat produced by oxidation of iron sulphide may have had a share in the process. The remedy proposed is to expel the air from the drums by means of an inert gas, such as carbon dioxide, before introducing the carbon bisulphide.

GEOLOGICAL.

By EDWARD A. MARTIN, F.G.S.

Phosphorescence in Calcite.

IN the *American Journal of Science*, Mr. W. P. Headden has been discussing the phosphorescence of certain calcites from Fort Collins, Colo., and Joplin, Mo. They possess the property of becoming phosphorescent on being insolated, and retain this property, in some cases, for a period of thirteen hours. Ordinary calcite under like conditions phosphoresces for one-third of a second, and aragonite for twenty seconds. Many other minerals become phosphorescent on being insolated, but the duration of this phosphorescence is very brief.

The Missouri specimens, which show a stronger phosphorescence than those from Colorado, occur in two forms, both in well-defined crystals. One is the well-known dog-tooth spar, only slightly modified by a rhombohedron; the other is a combination of two scalenohedrons.

The length of the period of phosphorescence was as much as thirteen hours, which was established by continuous observation. The duration, no doubt, actually exceeded this time, but it was distinctly visible, in some specimens, for the time given.

Mr. Headden concludes by remarking that "the limit of my present progress is the establishment of a probability that these calcites owe their property of becoming phosphorescent on insolation to the presence of some member of the yttrium group, which is represented by 13 parts in each 100,000 parts of the calcite."

A Deep Boring at Lincoln.

A communication was read at the meeting of the Geological Society on December 13, by Prof. Edward Hull, on "The Geological Conditions which have contributed to the Success of the Artesian Boring for Water at Lincoln."

The boring has its source of supply in strata which rise to the west, but to the east dip down towards the North Sea. There exists no information as to whether the eastern border of the water-bearing formation thins out against a concealed ridge of Palæozoic rocks. The water-yielding stratum is reddish soft, porous sand-rock, reached at a depth of 1,561 feet and penetrated to a depth of 474 feet. About one million gallons of water rise to the surface daily. The sand-rock belongs to the New Red Sandstone, which crops out from York to Nottingham with a breadth of about eight miles. The hydraulic pressure at the bottom of the boring is that due to about 2,035 feet, and the friction of the water in percolating the rock accounts for the fact that the water can be pumped down during the day but rises again in the night. The formations penetrated are the following:—Alluvium and Lower Lias 641 feet, Rhætic Beds 52 feet, Red Marl and Lower Keuper Sandstone 868 feet, Bunter Sandstone 454 feet. The quantity of water drawn from the New Red Sandstone, at and below the outcrop defined, amounts to not less than 20 million gallons daily, and the total available quantity of water percolating into the Sandstone amounts to about 300 millions.

Raised Beaches on the Chilian Coast.

Mr. O. H. Evans' paper on "The Raised Beaches of Taltal (Northern Chile)" proved extremely interesting. The town of Taltal is situated partly on the dry bed of a broad river and partly on a gently-inclined plain that fringes the bays of the coastal ranges far to the northward, and runs up the valleys to a considerable altitude and distance from the coast. The formation is impregnated with salt, and there protrude through it curiously-weathered remnants of former stacks and islets. The plain rises in terraces, the highest of which are somewhat obscure, and sometimes portions of these higher terraces are preserved in the stacks and islets. A second coastal shelf also occurs, marked by a line of shallow caverns. The beds of shells in the gravel, containing occasionally whale-bones, give satisfactory evidence of the marine origin of the terraces. Some of these shells are replaced by crystallised brine, and calcium sulphate occurs in some sections. Profound ravines (quebradas) occur in the massive rocks bordering the plain, although the climate is now so dry that rain-erosion is practically non-existent. Mr. Evans exhibited specimens in illustration of his paper, but he had, unfortunately, lost almost the whole of his collection, as well as his notes, in the earthquake at Valparaiso, whilst such as the earthquake spared had since either been burnt or blown up by dynamite.

ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

The Range of the Arctic Tern.

THE recent Scottish National Antarctic Expedition was emphatically successful, and especially so, perhaps, with regard to the biological work achieved by its officers. Much has already been published on this head, and Mr. Eagle Clarke added thereto at the meeting of the British Ornithologists' Club held on November 21. At this gathering he exhibited specimens of the Arctic Tern, which had been taken in the Weddell Sea and off the Antarctic Continent, where great numbers were observed as far south as 74°. All were typical Arctic Terns (*Sterna macrura*), and thus this bird has proved to have a greater latitudinal range than that of any

other bird, since this extends from 82° N. in summer to 74° S. or more in our winter.

Hoopoe in Orkney.

The *Field*, November 24, contains a record of a Hoopoe which was picked up dead near the Loch of Harray, near Stromness. It was in good plumage, but much emaciated, and had apparently been either shot or struck by a hawk, since blood was found upon the breast.

Spotted Crake in Co. Dublin.

A Spotted Crake (*Porzana Marnetta*) was shot on November 24 near Balbriggan, Co. Dublin, by Mr. G .B. Tunstall-Moore, who records the fact in the *Field* of December 1, 1906. This bird is of rare occurrence in Ireland, and has been obtained most frequently in the autumn.

Siberian Chiff-Chaff in Suliskerry.

At the last meeting of the British Ornithologists' Club (November 21) Mr. W. Eagle Clarke exhibited a Siberian Chiff-Chaff (*Phylloscopus tristis*), which had been obtained in Suliskerry, some 33 miles west of Orkney, on September 26, 1902.

Red-rumped Swallow at Fair Isle.

At this meeting Mr. Eagle Clarke also exhibited a Red-rumped Swallow (*Hirunda rufula*) procured at Fair Isle on June 2, 1906. During his stay at Fair Isle, where he was engaged in studying migration, Mr. Eagle Clarke obtained many other rare birds, including fine specimens of *Acanthis hornemanni*, *Muscicapa parca*, *Phylliscopus superciliosus*, *Cyanecula succica*, *Carpodacus erythrinus*, *Enuberiza pusilla*, *E. hortulana*, and *Lërocephalus streperus*—a really remarkable list, showing how much is yet to be done by careful study of our migratory birds.

Harcourt's Petrel at Hythe.

Dr. N. F. Ticehurst at this meeting exhibited a female of Harcourt's Stormy Petrel (*Oceanodroma castro*), which had been shot near Hythe, Kent, on November 8, 1906. This makes the second occurrence of this species in Great Britain, the first having been killed near Littledale on December 5, 1895.

Greyheaded Wagtail Breeding at Lydd.

A pair of Greyheaded wagtails (*Motacilla borealis*), with their nests, were taken by Mr. Bristow, of St. Leonards-on-Sea, from a marsh between Rye and Lydd on June 20, 1906. These were exhibited at the November meeting of the Club, and this is probably the first recorded instance of the breeding of this bird in Great Britain. We regret that the birds were slaughtered, and are not overjoyed at recording the taking of the eggs.

PHYSICAL.

By ALFRED W. PORTER, B.Sc.

The Writings of J. Willard Gibbs.

THE publication of the collected papers of the late J. W. Gibbs is drawing renewed attention to his important theoretical work on the borderland of chemistry and physics. Most of these are now available to the English reader for the first time. His paper on the Equilibrium of Heterogeneous Substances, first published in the Transactions of the Connecticut Academy in 1878, has, indeed, been translated into German by Professor Ostwald and into French by Professor Le Chatelier; but not until now has it been made generally accessible. This reticence is as remarkable as the paper itself is of importance in the study of physical chemistry.

One of the earliest of his papers is on Graphical Methods in the Thermodynamics of Fluids. Everyone is familiar with the indicator-diagram of a steam-engine, the ordinates of which represent the pressures of the steam at successive instants, while the abscissæ represent the corresponding volumes. The area enclosed by the diagram represents the work done while the piston goes through a complete cycle of positions. This is the only diagram which had been in use up to his day. Gibbs discusses all the various diagrams which might possibly be useful. One of these is the diagram in which the entropy of the steam is plotted against temperature. This diagram, which was independently suggested in Britain by J. MacFarlane Gray, is now in general use in connection with engines. It is probably not possible in this note to convey to anyone unfamiliar with entropy what is denoted by that term; but the following remarks may indicate how the usefulness of the notion of entropy arises.

If we reckon the heat that flows into or out of the steam during one complete cycle of changes (considering it as positive or as negative, according as it enters or leaves the steam respectively), the total amount is not usually zero, as is evident from the law of the conservation of energy. For, as a rule, energy at the same time passes out of the steam in the form of external work, and it is the total energy of all kinds which comes back to its original state. It is meaningless, therefore, to talk of the *heat in a body*. Heat passes in, it is true, but a fraction of it is at once transformed into work. If we spoke of the "heat in a body" as the algebraic sum of the amounts that had flowed in or out, its value for a pound of steam, for example at 100° C., would depend upon how many times it had been made to pass in any interval through a cyclic series of changes. But it was shown by Clausius that if you divide each small amount of heat which enters by the absolute temperature at which it enters, the sum of these quantities is zero for any complete cycle of changes in the steam (or other substance), provided the changes are such that they could be made to take place in a reverse way without making more than a minute change in surrounding bodies. The meaning of the last clause depends on the fact that heat will only flow from hot bodies to cold; hence, if the surroundings from which heat has been drawn while the changes are taking place in the direct way are at a much higher temperature than the steam, it would be necessary to make a considerable change in their temperature before the steam could be made to give up the heat to them again; such a case is said to be an irreversible one, and is to be excluded from the above statement. The quantity thus obtained, which depends only upon the state of the substances, is what is known as the *entropy* of the substance. If its value for each state be plotted against the temperature, areas on the diagram so obtained represent heat, and such a diagram is now in frequent use, especially in connection with turbines.

Gibbs shows that diagrams can be obtained in which all the standard lines for a *perfect gas* are straight. Thus, if log P be plotted against log V the following lines are all straight:—Lines of (i.) constant pressure; (ii.) constant volume; (iii.) constant temperature; (iv.) constant energy; and (v.) constant entropy. The first are vertical, the second horizontal, the third slope downwards from left to right at 45°, and so do the fourth; the fifth slope downwards from left to right at an angle whose tangent is γ where γ is the ratio of the specific heats of a perfect gas.

Optical Properties of Carbon Films.

Pure carbon, which has often been regarded as "a perfectly black body," that is to say, a perfect absorber of all kinds of rays incident upon it, is, in reality, transparent in sufficiently thin films. The transparency decreases, on the whole, in the infra-red as the wave-length of the incident radiation diminishes; but it does not do so in a perfectly regular manner. R. W. Wood, experimenting on carbon prisms, measured the refractive index for various lights, and found that red rays are more retarded than the blue; in other words, the prisms showed anomalous dispersion. Greater retardation, it must be borne in mind, implies a greater refractive index, and the law for normal dispersion is that the greater index corresponds to the shorter wave-length. This anomaly is what would result if there were a strong absorption band in the yellow. In the case of lamp-black a maximum of absorption was actually found by Nichols at wave-length 520 $\mu\mu$, and in the case of asphalte a similar band is found, but somewhat nearer the red end. A series of observations has recently been made by H. A. Clark (*Physical Review*, November, 1906), in which the

reflecting, refracting, and absorbing properties have all been measured on the same specimen. The values of these properties are all theoretically connected with one another. Films suitable for the purposes are obtained by using a carbon cathode in a vacuum and placing slips of glass in the path of the cathode discharge; a film is gradually deposited on the glass. Experiments have also been made upon the films deposited in incandescent lamps. The chief conclusions come to are that the properties of carbon films vary with the method of forming the deposit; there is an anomalous refractive index in the red ($\lambda = 610\,\mu\mu$); the reflection curves confirm this. Scarcely any difference has been detected, however, in the transmission curves of either kind of film. The transmission of cathodic films decreases almost uniformly from extreme red to $\lambda = 226.6\,\mu\mu$ (*i.e.*, in the ultra-violet), beyond which the films are opaque.

ZOOLOGICAL.

By R. LYDEKKER.

Some New Mammals.

A CONSIDERABLE amount of interesting matter relating to mammals has been published since my last communication. Specially noteworthy is a paper by Mr. M. W. Lyon, published in the *Proceedings* of the U.S. National Museum on a new species of great anteater (*Myrmecophaga centralis*) from Central America, which differs from the typical *M. jubata* (or *tridactyla*) of Brazil in several important features of the skull. That the last-named animal should range (as it has hitherto been supposed to do) without marked local differences from Guatemala to Brazil was in the highest degree improbable. In another issue of the above-named serial the same author has been enabled to demonstrate that the slow lorises of the genus *Nycticebus* inhabiting the islands of Borneo and Bauka differ from their more eastern relatives in the conformation of the skull of the adult, and probably also in the number of front teeth.

A third paper on mammals to which reference may be made is one by Dr. P. Matschie, of Berlin, on the forest-hog of the Ituri Forest, published by the authorities of the Congo Museum at Tervueren, near Brussels. The author is of opinion that the Ituri animal is specifically distinct from the one inhabiting Mount Kenya and the Nandi district (*Hylochœrus meinertzhageni*), and he accordingly proposes that it should be known as *H. ituriensis*. It may be added that an illustrated description of the former animal, by Baron Maurice de Rothschild and Mr. H. Neuville, recently appeared in the Paris *Bulletin de la Société Philomatique*.

Cavern Exploration.

In a paper recently contributed to the *Irish Naturalist*, Mr. R. J. Ussher, the well-known authority on the birds of Ireland, gives a preliminary account of the exploration of certain caves near Donnerail, in County Cork. The most interesting result of the investigation is the addition of the cavern race of the spotted hyæna of Africa to the extinct Irish fauna. The occurrence of a number of remains of immature mammoths is also a matter of interest. On the opposite side of the Atlantic the exploration of caverns in California has been conducted with great energy, and with results which may prove of great interest to the early history of man in America. An account of the exploration of one of these storehouses—The Samwel Cave—is given by Mr. E. L. Furlong in the September number of the *American Journal of Science*. After a list of the mammalian fauna, reference is made to certain objects discovered in this and other caves which may be of human workmanship, some of these objects being apparently contemporaneous with the cave fauna. Apart from certain stone flukes, of which the age is uncertain, the most important of these objects are polished splinters and spikes of bones, occasionally showing a perforation. These have been described in Vol. VIII. of the *American Anthropologist* by Prof. F. W. Putnam, who is strongly of opinion that they are the work of man.

How the Whelk Bores Oyster Shells.

More than half a century ago the late Prof. T. H. Huxley (in a paper published in the *Phil. Trans.* for 1853) announced, as the result of his own dissections and observations, that the whelk and other boring gastropods perforated the shells of molluscs by a kind of chain-saw action of their lingual ribbon, or "radula," the same action being continued during the process of licking out the soft contents of the victim in the case of univalve species. Subsequently this opinion was disputed by other observers, with the result that two divergent views have obtained with regard to the manner in which the boring is effected. On the one view it is assumed that the radula is stationary in relation to its supporting cartilage, and, consequently, that the rasping action is brought about by movements of the latter. According to the second view (that of Huxley) the radula moves independently of its support, playing backwards and forwards over the latter like a band over a pulley, so that the rasping action is due to the motion of the radula itself. The question, it may be hoped, has been finally set at rest by the careful investigations of Mr. J. C. Herrick on a large American whelk (*Sycotypus canaliculatus*), the results of which are published in the *American Naturalist* for October last. These, in the main, confirm Huxley's conclusions, with the reservation that the rasping action of the "chain-saw" takes place only during the return pull.

The Attis Spider's Eyes.

We have received cuttings from the *Eastern Daily Mail* of October 30 and subsequent dates containing an article by Mr. W. Strickland, of Singapore, on the wonderful phenomenon exhibited by the eyes of a spider of the Attis group. All the members of the group have, in addition to numerous smaller ones, a pair of large eyes which the author compares to gig-lamps; but in the particular species referred to these eyes are of exceptionally large size. The one specimen which the author has hitherto been able to obtain was captured at Buitenzorg, Java. When captured, the "gig-lamp" eyes were dark brown, like the body, but while Mr. Strickland was watching his prize, they suddenly changed to bright grass-green. "In a few minutes the creature with the same deliberation changed its eyes from grass-green to dark brown, and repeated the operation, which was completely under the control of its will, several times in succession. It almost seemed as though it took a pride in showing off its strange power; at any rate it evidently enjoyed the proceeding. It was as though a veil now of green now of dark brown diffused itself from above downwards behind the cornea." It is added that the colour of either one or both eyes could thus be changed. Unfortunately the creature arrived at the museum in a dying condition, and the offer of reward has failed to bring in other examples; but the same phenomenon was found to be exhibited by a smaller and commoner species. The phenomenon, according to the author, is unknown not only among other spiders, but in animals generally.

Papers Read.

At the opening meeting of the Zoological Society for the session 1906-7, held on November 13, a communication was read from Prof. R. Burckhardt on an embryo of the okapi, and a second by Mr. F. F. Laidlaw on a new turbellarian worm from Tanganyika. Mammals from Western Australia formed the subject of a paper by Mr. O. Thomas; while that gentleman and Mr. H. Schwann contributed a joint communication on Transvaal mammals. The last of a series of papers by Messrs. Melvill and Standen on the molluscs of the Persian Gulf and the Arabian Sea was likewise communicated to the meeting. At the meeting of November 27, Mr. P. A. Coward discussed certain habits of the lesser horseshoe bat; Messrs. E. A. Smith and H. H. Bloomer communicated observations on East African molluscs; while Mr. W. Woodland offered suggestions with regard to the origin of the renal portal system of blood-vessels, and likewise described the anatomy of *Centrophorus calceus*. The skull and skeleton of an extinct crocodile, *Goniopholis crassidens*, from the Wealden strata of the Isle of Wight, formed the subject of a paper read by Mr. R. W. Hooley at the meeting of the Geological Society on November 21.

CORRESPONDENCE.

Brakes.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—In an article on brakes in the November number of "KNOWLEDGE & SCIENTIFIC NEWS" I notice the sentence, "This argument may serve as an illustration of the danger attending arguments based on the doctrine of energy."

It seems to me that this stricture on the value of methods based on the doctrine of energy is wholly unwarranted. The fallacy lay in the illogical assumption that two quantities are necessarily greater than one.

Further, the action of a brake does not necessarily produce sliding motion.

In the following analysis I use P to represent the brake couple produced by friction at the brake itself and at the axle, and Q to represent the moment around the axis of the frictional force called into play at the rail.

Then if P is greater than the maximum value of Q, the wheels will lock, and the retarding force of the rails is a maximum.

If P is less than this value, the wheels will continue to revolve and only such a force will be called into play at the rails as to make Q equal to P.

Hence we see that the greatest retarding force is called into play when the wheels are locked.

Further, since these couples P and Q are very large, and the *vis viva* of the wheels small, we see that the motion is (except for minute intervals of time) either pure rolling or pure sliding, the sliding being the more effective.

If the lock is only just effective, and a rough portion of the rail be reached, then the sliding might be converted into rolling, which would continue until the roughness was passed. Sliding would again intervene, but on a different portion of the rim.

These interchanges of pure rolling and pure sliding might be very frequent, and so prevent the formation of a "flat."

In this way only, then, can "mixed" rolling and sliding be more effective than a complete "lock."

Yours truly,
H. S. H.

[The wrong (but now discarded) conclusion, based on an energy argument, is one which several of my friends came to as well as myself; that is the only reason I think such an argument to be attended with danger. I am glad that "H. S. H." agrees with me as to the source of error. I am equally glad that he has not attempted to employ an argument from energy in the rest of his letter. I am also in *general* agreement with him (though he does not seem to think this) as to the suggested mode in which mixed rolling and sliding occurs. Into the details of this I did not enter in my note, which was probably too short except to set others thinking.] A.W.P.

Basaltic Columns.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—Mr. Martin, in his interesting paper on the Giant's Causeway, does not allude to a possible *concretionary* origin of the blocks. In a "Grotto" I once saw in Germany, but cannot recall the place, the basaltic pillars were composed of balls in vertical rows. The blocks had weathered into that form. Mr. Martin alludes to the "cup and ball" joints. If, as a hypothesis only, we assume centres of contraction, due to a concretionary process, to arise along a vertical line, such would account for hexagonal pillars with cup and ball joints, the blocks being resolvable into balls by weathering.

If one taps a thin biscuit in the middle on a table, it almost invariably breaks along three lines approximately at 120° apart; so contraction round spheres in contact would produce the hexagon, as equal spheres touch at six points on the same plane.

Concretionary processes are, of course, extremely common. Thus they used to be dredged off Felixstowe for making Roman cement, being derived from the London clay. Pisolitic limestone of the Oolites and botryoidal (magnesian) limestone of the Permians are other instances. I have found them in a metamorphic state in Jersey, so that they may equally well occur in basalt.

As to the *causes*, I should much like to hear what present-day geologists have to say about the origin of concretions. In the pisolite there is usually a fragment of some organism in the middle, but why the molecules of carbonate of lime are attracted to it, I do not know. In basalt and metamorphic rocks some other centres of attraction must exist.

In the basalt *two* causes would have to be discovered—(1) Why there should be centres of aggregation producing contraction at all; and (2) Why they should lie on one and the same vertical line.

There is a basaltic quarry a few miles from Coblentz on the east side of the Rhine. Short pillars (about 6 inches diameter) are extracted and used as posts to carry a chain by the side of the road running by the Rhine. In these it looks as if the "*centres* of concretion" had become a *straight line*, so that the basalt never broke up into blocks at all.

Faithfully yours,
Leamington. GEORGE HENSLOW.

Lightning Flashes from Earth to Cloud.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

DEAR SIRS,—Apropos of Dr. Lockyer's interesting article upon Lightning, I might mention that during the summer of 1905 a short storm passed over the south-west of London about mid-day.

While watching this from Clapham Common I saw a flash which, apparently, started from earth, travelled vertically upwards for a short distance, then turned at a right angle and went due west, finally the streak "swelled out" into a large ball of fire and vanished.

The thunder which followed in about 10 seconds was quite consistent with the character of flash, viz., a short peal, slight, momentary modulation, a long peal ending in a loud report like that of a heavy gun.

Yours faithfully,
66, Lillieshall Road, HERBERT WILKINS, L.R.C.S.I.
Clapham Common, S.W.

REVIEWS OF BOOKS.

ASTRONOMY.

An Atlas of Hindu Astronomy with Key and Notes, by Kalinath Mukherji, B.A., B.L.; price 3 rupees; **Popular Hindu Astronomy**, Part I., by the same author (Calcutta: Han Press).—The author, a former undergraduate of the Krishnagar College, was inspired among others to take an interest in astronomy by Sir W. J. Herschel, of the Indian Judicature. The atlas supplies the native student with maps modelled on those with which English readers are familiar, but with the more or less conventional constellation figures replaced either by the equivalent from Indian mythology, or by different arrangements which appear to be commonly accepted in India. Some of the changes are interesting, thus, the well-known square in Pegasus becomes a sort of bedstead with turned legs, Orion a deer transfixed with an arrow (the Belt), and Argo an ineffective-looking paddle-steamer. There are also diagrams of the planetary system, comets, and eclipses. The letterpress being in Oriental character does not appeal to English readers, only the names of constellations and bright stars being translated. The other work, however, can be used in conjunction with the maps, being to a great extent in English, though bristling with quotations from Indian epics. There are many interesting legends connecting the stars with Indian mythology, but very little astronomy as generally understood. As is only to be expected, there are numerous typographical errors, more than a hundred of which are given as errata at the beginning of the little book, but the list is still incomplete. The Milky Way is likened to a piece of white cloth, worn through in places, *twelve feet broad*. The author accepts the translation of Vedic scholars, but not their interpretation, which he considers is refuted by looking at the sky. We are not sufficiently familiar with Vedic literature to take sides on this question. He also makes considerable use, for purposes of parallelism, of the constellation studies of Mr. Robert Brown, jun., to whom, as also to Professor Henry Stephen, he owns his indebtedness as to the interpretations, other than Indian, of the star names and figures. He uses numbers

instead of Greek letters for his constellation stars, and has at times revised the order when he considers Bayer's system not consistent, so that identification is not always easy.

GEOLOGY.

The History of Devonshire Scenery, by Arthur W. Clayden, M.A.; pp. 195 and Index; 43 photographic illustrations (Exeter: James G. Commin; London: Chatto and Windus; price 10s. 6d. net).—Principal Clayden's contribution to the geology of Devonshire is one of those books which it is a pleasure to read. It is complete in itself, is scientific in every way, and yet can be read with profit by even a beginner in the scientific study of scenery. Commencing with the earliest rocks, and after a short discussion, dismissing the terms "azoic" and "eozoic" in favour of "pre-Cambrian," we are told that the green and grey crystalline rocks which make up the country by Salcombe, and reach from the Bolt Tail to beyond the Start, are believed by some geologists to be of pre-Cambrian age. The Devonian rocks are fully described, and a special chapter is given on the Culm measures. We should, of course, expect to find a good deal about the Dartmoor granites and other volcanic rocks, and we are not disappointed. "The Salt Lake Period" and "The Age of Reptiles" are interesting chapters in the history of the evolution of the county, and then with "The Return of the Sea," we have a chapter on the "Chalk," and the problems as to the ancient coast lines are temperately and judiciously discussed. "The Bovey Lake" calls to mind the ever-recurring problem as to whether the Bovey Tracey lignites and clays are Eocene or Miocene, although now they are acceptably placed with the Oligocene beds of the Isle of Wight. If we want evidence to show subsidence of the land, we have it in the fact that the basin in which are these beds extends at least 400 feet below the present sea level, as proved in a boring recently made near Heathfield station. The illustrations are excellent in every way, and by presenting actual photographs to the reader they assist in preparing him for the appearance which the various rocks really present in the field. And where at all obscure, a key has been usefully added on the same page, showing clearly the dividing lines to be looked for. E. A. M.

METEOROLOGY.

British Rainfall, 1905. (E. Stanford, London, 1906, 8vo., 359 pp.; 10s.).—The title page of this (the forty-fifth) annual volume has been somewhat altered, and now reads: "British Rainfall, 1905. On the Distribution of Rain in space and time over the British Isles during the year 1905, as recorded by more than 4,000 observers in Great Britain and Ireland, and discussed with Articles upon various branches of Rainfall work, by Hugh Robert Mill." The late Mr. G. J. Symons, F.R.S., in 1860, commenced the collection of rainfall statistics, and published them in an annual volume entitled "British Rainfall." This work, which he continued up to the time of his death in 1900, is now ably carried on by Dr. H. R. Mill. These annual volumes are rich storehouses of rainfall data, and they become more valuable year by year. The growth of the number of observers has been as follows:—

1861	472	1891	2799
1871	1504	1901	3506
1881	2145	1905	4096

The present volume contains in Part I.:—(1) A Report to the Observers, without whose generous work "British Rainfall" could not exist; (2) Original Articles, dealing with a remarkable publication of rainfall data in Germany, and with the relation of evaporation to other meteorological phenomena; (3) Tables of the amount of evaporation at 11 stations, of the duration of rainfall at 8 stations, and of the complete daily observations of rainfall at 10 stations; (4) An account of the staff of observers and of changes in the stations at work, together with a map showing those parts of the country where new observers are most urgently wanted; and (5) a long obituary list. In Part II. the conditions of 1905 are exhaustively treated as to (6) Observers' Notes on the rainfall and weather; (7) Heavy Falls of Rain, their distribution over the country, and their relation to atmospheric disturbances, with several maps; (8) The distribution of rainfall in time, including the number of rain days classified according to amount of fall, droughts, and rain spells; (9) The monthly and annual rainfall in relation to the average; and (10) The General Table, giving the names of all observers or responsible authorities, particulars as to position and exposure of the rain gauges, the total annual rainfall, and the number of rain days. Taking the year as a whole it appears that 1905, like 1904, was a dry year. The distribution of rainfall over the British Isles was:—

	1905.	Difference from Average.
England and Wales ..	28·80 ins.	−5·62 ins. or −16 per cent.
Scotland	43·04 ,,	−2·35 ,, ,, −5 ,,
Ireland	35·80 ,,	−4·72 ,, ,, −12 ,,

The greatest rainfall in 1905 was 176.60 ins. at Glaslyn, Snowdon, Carnarvonshire, and the least 14.57 ins. at Shoeburyness, Essex.

PHOTOGRAPHY.

Collodion Emulsion, by Henry Oscar Klein (London: Penrose and Co., 109, Farringdon Road, E.C., 1905; price 5s. net.)—This is a comparatively small volume of 95 pages, and is written by a practical man for practical workers. It seems a pity that collodion emulsion processes should have been almost driven out of existence by other methods. It may be considered a debatable point as to whether it is a case of the survival of the fittest, and, therefore, the author does good service in presenting the subject with its modern variations and applications in a convenient form. Of course, the use of collodion emulsions is a favourite topic with the author, but he does not recommend them without discrimination, for he points out their disadvantages for very fine line work. He describes the applications of emulsions to the preparation of ferrotypes, lantern slides, and transparencies, photographing on wood, for photo-mechanical purposes, and in three-colour work by various processes. The sensitising of emulsions for colour is treated of at length. We wish that the author had restricted himself to the practical aspects of the subject for his few excursions into theoretical matters are, to say the least of them, unfortunate. If these parts are to be retained in future editions they should be thoroughly revised.

SOCIOLOGY.

Sociological Papers. Vol II. By Various Authors. Published for the Sociological Society. (London: Macmillan & Co., 1906; price, 10s. 6d.).—This volume comprises the papers read before the Sociological Society during 1904-5, with the discussions that followed. Sociological problems are so complex and many-sided that from one point of view or another they can scarcely fail to appeal to all thinking people, and the volume contains much of universal interest and importance. The editors have suggested a classification of the predominant characteristics of the several papers according to their methods of approaching the subject. Thus the Historical Approach is illustrated by Mr. J. S. Stuart-Glennie's papers, "*The Place of the Social Sciences in a Classification of Knowledges*," "*The General Historical Laws, the Anthropological Bases of a Science of Socialisation*," and "*The Application of General Historical Laws to Contemporary Events.*" The Ethical Approach by Professor Höffding with "*On the Relation between Sociology and Ethics*," and by Dr. Westermarck in "*The Influence of Magic on Social Relations.*" The Psychical Approach by Professor Sadler in "*The School in some of its Relations to Social Organisation and to National Life.*" The Biological Approach by Mr. Francis Galton in "*Restrictions in Marriage*," "*Studies in National Eugenics*," and "*Eugenics as a Factor in Religion.*" And the Geographical Approach in Professor Geddes's paper on "*Civics: as Applied Sociology.*" Mr. Galton's paper on "*Restrictions in Marriage*" is designed to meet the objections often urged against Eugenics, that human nature would never brook interference with the freedom of marriage. He takes as examples the questions of monogamy, endogamy, exogamy, the Australian system of marriages, taboo, prohibited degrees, and celibacy to show how unquestioningly mankind, at all grades of civilisation, has submitted to marriage restrictions, when these have been sanctioned or imposed by custom, law or religion. The three papers of Mr. Galton, and the 30 pages of discussion to which no less than 26 well-known workers contribute, demonstrate the author's claim that "Eugenics is a virile creed, full of hopefulness, and appealing to many of the noblest feelings of our nature." Dr. Westermarck brings a wealth of illustration to prove the in-

fluence that magic has had on the notions of social rights and duties. This is seen in the increase of the parents' powers over their children, especially with regard to the importance attached to the blessings or curses of a parent. It is a fusion of magic and religion that has produced our conceptions with regard to the duty of charity, "By niggardliness a person may expose himself to supernatural dangers, whereas liberality may entail supernatural reward." Most striking is the influence of magic in the treatment of the stranger in early society, and his transformation from the "*hostis*" to the honoured guest. Although the rules of hospitality are in the main based on egoistic considerations, ("Be not forgetful to entertain strangers, for thereby some have entertained angels unawares"), and although the hospitality may be of short duration (as the S. Slavs tersely express it, "A guest and a fish smell on the third day"), yet the custom has been a most important factor in early society. Professor Geddes urges the importance of concrete observation, "a first-hand experience, an impulse and message from life and action;" and a suggestive example of concrete and applied sociology is given in the study of "*Civics*" (continued from Volume I. of the publications of the Society). In the discussion that followed, Mr. Tomkins (of the London Trades Council) sketched the advantages that would accrue, "if before any person was allowed to serve on our different public bodies, he should be required to attend a course of lectures such as those given by Professor Geddes on Civics;" in the same way it would be well if all those responsible for the disentangling of the educational problem were to study Professor Sadler's paper on "*The School in some of its Relations to Social Organisation and to National Life.*" Professor Sadler notes the three different influences at work in English Educational policy, which, if pressed to their logical conclusions, come in conflict. They are, briefly, the belief in a unified school system; the desire to develop alert individualism and initiative; and the belief in state-encouraged groups of like-thinking people. He concludes: "An educational system to be effective must be in harmony with national sentiment, and English national sentiment has for centuries shown a strong preference for allowing great freedom in the utterance of personal conviction (and, therefore, for permitting great freedom in imparting such convictions through education), combined with an equally strong preference for a sufficient measure of social order, in order that the business of the nation may be effectively carried on."

ZOOLOGY.

The Life of Animals: The Mammals, by E. Ingersoll; pp. vii. and 555, illustrated (New York: The Macmillan Co.; and London: Macmillan and Co., Ltd., 1906; price 8s. 6d. net).—For those who do not care to be troubled with the scientific names of the species and genera, this is, perhaps, one of the best popular books on mammals that has ever come under our notice; the subject being treated in an attractive and yet generally accurate style, with just enough of description to enable the different species to be easily recognised, even without the aid of the numerous illustrations. As regards the latter, the author has been in the main well served by his artists; many of the attractive coloured plates and of the photographs being excellent both as works of art and as life-like portraits of the animals they represent. While many of the illustrations are new, others will be recognised as old friends. In such a mixed series all cannot be expected to be on the same platform of excellence; and in one instance a cut does duty for an animal for which it is obviously not intended, while a second omits one of the most striking features of the species it is intended to represent. In the text, amid the general excellence of treatment, we may likewise recognise a few passages which might well be amended; as, for example, the statement that the red American lynx differs so slightly from its Canadian cousin as not to be worthy of specific distinction. In the main the work is thoroughly up-to-date, including, for example, a summary of recent discoveries relating to the ancestry of the elephant; and the accounts quoted are mostly those of experts, either as field or closet naturalists. The book may confidently be recommended to all lovers of natural history—young or old. It may be added that the scientific names of many species are given in the index.

MISCELLANEOUS.

The Norwegian North Polar Expedition. Scientific Results. Edited by F. Nansen; Vol. V. (London: Longman's Green, and Co.; price 20s. net).—The contents of this volume, which is as well illustrated and as handsomely got up as its predecessors, includes three articles, forming Nos. XIV.-XVI. of the entire series. We can but regret that limitations of space prevent our giving a notice of the first and second (which are of the most general interest) adequate to their importance; both being excellent pieces of work, which afford evidence of the many-sided nature of the researches undertaken by the savants of this memorable expedition. The first article, by Mr. O. B. Bøggild, is devoted to the bottom-deposits of the Polar Sea. One of the results of the expedition was to prove the existence of a large, deep North Polar basin, the bottom of which has been found to be covered with deposits of unexpected fineness. An inference from this is that the ice, which generally drifts from Bering Strait towards the sea between Greenland and Spitzbergen must be mainly sea-ice, with a small proportion of coast or river ice from Siberia and North America. Very interesting is the second article by Mr. V. W. Ekman on "dead-water," a phenomenon met with in the Norwegian and Arctic Seas. It is due to a layer of fresh-water above the salt-water of the sea; and a vessel passing through it generates large waves at the plane of division between the two liquids which offer an unexpectedly high resistance to her progress. In the third article the editor describes the Protozoa, or animalcules, to be met with on the ice-floes of the North Polar Sea.

Serials.—We have to acknowledge the receipt of Part 33 of the *Transactions* of the Yorkshire Naturalists' Union, which forms the concluding portion of the second edition of "North Yorkshire; its Botany, Geology, Climate, and Physical Geology," by J. G. Baker. The conclusion of the account of the flowering plants, together with lists of the mosses and liverworts, constitute the contents of this fasciculus. We are indebted to the University of California for a copy of a memoir by Mr. A. Hodlicka (published by the University in its Archæological and Ethnological serial) on collections of skulls of the ancient and extinct natives of the Californian peninsula. Excellent figures and elaborate measurements are given; so that the memoir should prove of great value to anthropologists. Mr. H. R. Watkin has favoured us with a copy of a paper on the "White winter coat of certain creatures," in which he refuses to accept the view of Dr. Tronessart that the winter whitening of mammalian hair is due to the action of phagocytes. Indeed, he is somewhat sceptical in another way, seeing that he is not assured that British park-cattle are semi-albinos.

Also to hand is a copy of the Report of the Colombo Museum for 1905, published as Part IV. of *Ceylon Administration Reports*. From this it is satisfactory to learn that it has been resolved to enlarge the museum buildings, provided that the Colonial Government sees its way to supply the requisite funds. Dr. Willey, the Director reports that the Museum continues to make satisfactory progress. The Committee of the Bristol Museum and Art Gallery has published a fully-illustrated pamphlet of 75 pages, detailing the history and progress of that Institution since its foundation in 1772. The illustrations display the imposing proportions of the buildings, and likewise give a clue to some of their contents. It is almost unnecessary to state that both in the matter of natural history and of art the Institution possesses a number of very valuable and interesting specimens.

A PERPETUAL CALENDAR.—We have received from Messrs. Philip and Son a specimen of their Universal Perpetual Calendar, which is the most ingenious and complete example of its kind that we have ever examined. It is the work, evidently a labour of love, of the Rev. J. P. Wiles, M.A., and we may congratulate him especially on the simplified form to which he has reduced the calendar. Many such devices require elaborate manipulation before they will give the desired results, but this calendar can be adjusted with the greatest ease to any year between 1 A.D. and 2,000 A.D., and will, in addition, furnish the New Moons and the date of Easter, both new and old style, for those years.

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, B.A., F.R.M.S.

Royal Microscopical Society.

NOVEMBER 21, Mr. A. N. Disney, M.A., B.Sc., in the chair. The Curator described two old microscopes which had been presented to the Society's collection. One was a Culpeper microscope of early 18th century date, presented by Mr. Wynne E. Baxter; the other, of late 18th century date, was made by Dolland, after Cuff's model, and was presented by Mr. C. Lees Curties. Dr. Hebb exhibited a new porcelain filter, made by Doulton and Co., suitable for laboratory work, and he also exhibited for Mr. Taverner a small filter bottle for filtering micro mounting fluids. Mr. Conrad Beck exhibited an optical bench for illumination with either ordinary or monochromatic light, arranged to show experimentally that *A. pellucida* could be resolved by green light, when, under the same conditions, yellow light failed to resolve it. Messrs. Zeiss exhibited a special microscope for photo-micrography of metallurgical specimens. Mr. J. W. Gordon gave a summary of his paper, "On the Use of a Top Stop for Developing Latent Powers of the Microscope," and exhibited his apparatus, pointing out that a top stop admits of variation between the proportion of the refracted and unrefracted light which passes the instrument, and thus renders more conspicuous a particular feature of the object. In illustration, he exhibited photographs taken with an achromatic oil-immersion lens of N.A. 1.0, which were designed to show how, by means of a top stop, an objective of this aperture might equal the performance of an objective of much wider aperture. Mr. Rheinberg contended that the use of a stop in the Ramsden circle of a microscope was, from an optical point of view, equivalent to the use of a stop in the upper focal plane of the objective, and that the use of a stop which puts out of use the central portion of an objective deteriorates and falsifies the image. Mr. Conrad Beck observed that if the course of the rays were followed, it would be found that there was but one point through which all the rays passed symmetrically, and that was in the Ramsden circle, so that this was the best place for the insertion of a patch stop, and he controverted Mr. Rheinberg's view that the putting of a stop in the posterior focus of the lens gave the same results. Mr. Conrady said Mr. Gordon had repeated his idea that the well-known *visibility* of single minute objects proved the accepted limits of resolution to be wrong, and laid stress on the fact that mere visibility and resolution were totally different things, the former being merely a question of contrast, an object, however small, being seen if it contrasted sufficiently with its background. Stars that were probably below $\frac{1}{100}$ of a second in arc in apparent size were visible to the naked eye, which had a limit of resolution of about 60 seconds, and we had here visibility of objects measuring less than $\frac{1}{6000}$ part of the least distance at which *two* such objects could be separated and resolved. He considered the delicate tracing on diatoms referred to by Mr. Gordon to be spurious appearances of the intercostal order. Mr. Gordon briefly replied, agreeing with Mr. Rheinberg's statement that a top stop in the Ramsden disc was equivalent to a stop placed in the upper focal plane of the objective, subject to Mr. Beck's criticisms, and to the fact that the wave fronts were plane in the former position and spherical in the latter.

Quekett Microscopical Club.

November 16. A paper by Mr. F. P. Smith, on "The Classification of the British Spiders of the genus *Lycosa*," was taken as read. Mr. F. P. Smith gave a lecture on "Vagabond Spiders." He said that the more highly specialised forms of spiders fell pretty naturally into two groups, the first—probably derivatives of the genus *Pachygnatha*—including all those species which made either orbicular, "saucer," or "tangle," snares, and second, those which constructed no snare at all. The three principal groups of vagabond (wandering) spiders were represented by the typical families Lycosidæ, Thomisidæ, and Salticidæ. The females of the genus *Lycosa* carry the egg-sac about attached to the spinners, and the young, when hatched, live for some time upon the back of the mother. Spiders of the genus *Pirata* are able to run upon the surface of water, and *Dolomedes* constructs a raft and makes considerable voyages. The Crab-spiders (Thomisidæ) have a peculiar articulation of the legs which enables them to travel forwards, sideways, or backwards with equal facility. A short description was given of the more striking characteristics and habits of the Salticidæ, of which there are some 33 British species at present known. The lecture was illustrated with a number of especially interesting lantern slides, some of "face" views of spiders, producing not only a striking effect, but demonstrating clearly the arrangement of the eyes, and was concluded with a series of five photographs showing the attack upon, and capture of, a house fly by *Marpessa muscosa*.

Microscope Slides.

Mr. H. W. H. Darlaston, of 20, Freer Road, Birchfield, Birmingham, has sent me particulars of a somewhat novel method of circulating slides. Briefly the arrangement is that for a subscription of two guineas, 600 slides will be sent, post paid, in 12 monthly parcels of 50 slides each. From each monthly parcel five slides, 60 in all, may be selected and retained by the subscriber free, and he may also select further slides at an all-round price of 6d. each. For a subscription of one guinea, 25 slides per month will be sent, and two per month retained, whilst for half a guinea twelve slides per month are sent, and one per month retained. Of the slides sent me as specimens I can speak highly; they are beautiful examples of the mounter's art, and in no way inferior to slides sold at double the price.

Microscope Material.

By the kindness of Mr. Ernest Heath, of Cardiff, I am able to offer for distribution to my readers a considerable quantity of anchor mud and dredger sand from the Adriatic. Mr. Heath says: "I made these gatherings myself, and a friend sent me a great many. They extend over a fairly wide area on the eastern coast from Trieste to Spalato. Your readers will, I think, find them very rich in Foraminifera and Mollusca, but the diatoms I expect I have pretty well washed out in getting my own floatings. There is a very wide range of Foraminifera and abundant beautiful specimens of *Peneroplis planatus*. I have also had some very curious and abnormal specimens of *Polymorphina*. The Adriatic is one of the richest seas in Foraminifera. I was bathing from the shore on one of the Brioni Islands, and as I walked into the sea the sand rose up and floated around my legs in clouds, just the same as one

sees it when washing and floating the gatherings. I should think that 50 or 60 per cent. of the sand is composed of the empty shells." In a further letter, Mr. Heath says: "With reference to procuring supplies of dredgings and ocean ooze, one of the best plans I know of is to get in with an officer of one of the cable-laying steamers, which take soundings in great depths. I have so far failed myself to get to know one, but hope some day I may do so. I have had a lot of very excellent material, however, from the steam trawlers that work out from Cardiff. I wrote to a member of one firm asking him if he would kindly allow me to board his trawlers when they arrived in, to scrape the sand from the crevices of the trawls, and he most kindly gave his superintendent instructions that I was to have every facility, so that I collected from the different trawls from pretty nearly all the grounds they visited, including off 'The Smalls'; off 'The Wolf'; the Atlantic, 150 miles west of Lundy; off the Basketts (Cape Clear, S.W. Irish coast); 30 miles S. of Kinsale Head; off Ushant, Finisterre, &c. I also had some very fine material collected by an officer on H.M.S. *Euryalus* when on the Australian station. These include Broken Bay, Hawkesbury River, N.S.W., 7 fathoms; Largs Bay, S.A., 6 fathoms; Auckland, N.Z., 6 fathoms; Port Lincoln, S.A. (poor), 9 fathoms; Hobson's Bay, Melbourne (very poor), 5¼ fathoms; Sydney Harbour, N.S.W. (very rich), 8½ fathoms; off Ceylon, Indian Ocean, 35 fathoms; Colombo Harbour, 7 fathoms; Suez (Egypt), and Port Said, 28 fathoms. He also had some from Aden, but said it putrified and stunk his cabin out so he had to commit it to the deep again. This officer is now in home waters, and has offered very kindly to collect for me more material when the opportunity occurs. The Adriatic anchor mud, &c., with the exception of five, which I got myself, were sent me by an officer in the Austrian Navy, and were taken from a torpedo-boat, on which he was cruising. One of them was actually taken from a discharged and recovered torpedo, which should have had a very good sample as it would be running along the bottom for some little distance when slowing down. This officer I had interested very much when I was over there last year, showing him with a pocket lens of 20 diameters the lovely little shells. He has also promised to send me more when he has an opportunity." I wish I could reproduce more of Mr. Heath's very interesting letters, which show how an enthusiastic collector may enlist the help of others for his hobby. Those of my readers who would like some of this sand must send me a stamped addressed envelope, a small tin box, and the coupon to be found in the advertisement columns of this issue. May I add that the number of applicants is generally so great that I cannot pay any attention to applications which do not carry out *all* of these simple conditions. It would be amusing were I to detail some of my experiences in distributing material of this nature.

Notes and Queries.

C. E. G. (Shanghai).—Your letter interested me very much, and I feel sympathy for anyone working under your conditions. I think you cannot do better than devote your attention to mites, and I would refer you to an article on the subject contributed by Mr. C. Warburton to these columns, and published in May and June, 1904. Mr. Warburton is one of the authorities on the subject, and in his article gives notes as to collecting, &c. If you decide to take up the matter definitely I shall be glad to put you into communication with him, or with others who are likewise interested in the subject. With regard to the photographs, yeast is very difficult on account of its want of contrast, and I shall, therefore, not be too critical about it. The others are good attempts for a beginner, and their most serious fault is that the slides themselves are not satisfactory. In making mounts of insects you cannot be too painstaking in the initial stages of preparation. If you begin by treating with caustic potash, the whole process must be carefully watched, and the turpentine stage must be equally closely watched, but a section that is not transparent, or one that is not uniform, is useless for photography. In the photograph of the flea, for instance, the legs are so pale as to have no contrast, whilst the body is almost opaque. A similar criticism applies to the head of the mosquito, and to the beetle's head. You have also a tendency to get an illuminated disc that is not quite uniform, which spoils the appearance of the photograph, the remedy being careful centring and adjustment of all the optical arrangements, especially the condensers, as laid down in my articles on photo-micrography in this journal (November, 1905, to June, 1906). Some of the photographs are not precisely focussed, and in others there is a tendency to stop down the condenser too much. Ordinary low-power objectives are not satisfactory for photo-micrography, and it is well worth purchasing one or more of the plano-lenses made by various opticians. W. Watson and Sons make a good series under the name of "Holostigmatic" at £4 each, of which the most generally useful are the 3-in. and 3½-in. Reichert also makes a good series, of which the most useful are a 3-in. at 50s. and a 4-in. at 60s. Zeiss' Micro-planars are excellent, but they cost £6. All these are used without eyepiece. Watson's Variable Magnifier is unsuitable for photography, being designed as a hand or dissecting lens. Achromatic lenses perform fairly well without eyepiece, but the image is sharpened by using a projection ocular, the lower in power the better.

W. M. H. (Winchester).—There are several methods of reproducing drawings, whether from illustrations in books or not, but the simplest way is to photograph them direct. For this any ordinary photographic camera is suitable, provided it has a camera extension which will allow it to photograph at quite a short distance. For my own work I use a £5 5s. ¼-plate "Kodak," which has a camera extension which enables me to focus an illustration set up about 17 inches away, the lens being a good one and fairly flat in the field. By a little ingenuity an ordinary photographic lens could be fitted for this purpose at the end of a photo-micrographic camera. It is then only necessary to set the page to be photographed opposite to the lens, making sure that it is vertical, at right angles, and that the whole page is flat, to illuminate it with as strong a light as possible, and to photograph as usual. A suitable wooden stand is easily made. In making the negative it is important to get sharp definition and a clean ground, any fogginess spoiling the slide for lantern purposes. By using ¼-plates it is easy to print ordinary 3¼-inch square lantern slides by direct contact with the negative thus made, the two plates being printed in an ordinary frame, the lantern slide taking the place of the ordinary printing paper, and exposed to light in the same way. I have had excellent results with Edwards' "Kristal" plates, full instructions for development, &c., being sold with each packet. It is best to take the negatives on a ¼-plate if possible, as otherwise they have to be reduced in size, which is a nuisance. I assume that you are familiar with ordinary photographic methods, in which case the above hints will, I hope, serve your purpose.

Ocean Ooze and Diatomaceous Earth.—Mr. G. E. O. Mullins, of Bristol, will be grateful if any reader can tell him where he can procure ocean ooze. He says he has watched the advertisements in the scientific journals for some time. He would also be glad to know where he can obtain the diatomaceous "mountain flour" of Norway. With regard to the former inquiry, Mr. Mullins will probably read with interest the remarks accompanying Mr. Heath's offer of dredgings from the Adriatic in another part of these columns. Mr. Heath very kindly offers to allow him to select from the material mentioned.

[*Communications and inquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge. Correspondents are requested not to send specimens to be named.*]

The Face of the Sky for January.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 8.8 and sets at 3.50; on the 31st he rises at 7.44 and sets at 4.44.

The earth is nearest the Sun on the 2nd, when the Sun attains his maximum apparent diameter of 32′ 35″.

Sun-spots are not very numerous, though an occasional group may be observed on the solar disc.

There will be a total eclipse of the Sun on the 14th, invisible in this country, but visible in Central Asia as a total eclipse, and in India as a partial one.

The positions of the Sun's axis and of the centre of the disc are given below:—

Date.	Axis inclined from N. point.	Centre of disc S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Jan. 1 ..	2° 16′E	3° 7′	137° 56′
,, 6 ..	0° 10′W	3° 41′	72° 5′
,, 16 ..	4° 58′W	4° 44′	300° 24′
,, 26 ..	6° 32′W	5° 37′	168° 45′
Feb. 5 ..	13 41′W	6° 20′	37° 5′

THE MOON:—

Date.	Phases.	H. M.
Jan. 7 .	☾ Last Quarter	2 48 p.m.
,, 14 ..	● New Moon	5 57 a.m.
,, 21 ..	☽ First Quarter	8 42 a.m.
,, 29 ..	○ Full Moon	1 45 p.m.

There will be an eclipse of the Moon on the 29th, but it is invisible in this country.

OCCULTATIONS:—

Date.	Star's Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N point.	Reappearance. Mean Time.	Reappearance. Angle from N. point.	Moon's Age.
			p. m.		p. m.		d. h.
Jan. 21	ξ^2 Ceti	4·3	9 7	94°	10 12	224°	7 15
,, 26	ν Geminorum ..	4·1	6 40	112°	7 45	231°	12 13
,, 27	56 Geminorum ..	5 0	7 39	38°	8 27	317°	13 14
,, 27	31 Geminorum ..	5·7	10 30	87°	11 52	282°	13 17
,, 31	l Leonis	5·3	9 19	61°	10 5	333°	17 15

THE PLANETS.—Mercury (Jan. 1, R.A. 17^h 25^m; Dec. S. 22° 50′; Jan. 31, R.A. 20^h 48^m; Dec. S. 20° 2′) is a morning star in Scorpio during the early part of the month. The planet is not well placed for observation, and towards the end of the month is out of range, as he is approaching superior conjunction with the Sun.

Venus (Jan. 1, R.A. 16^h 3^m; Dec. S. 16° 21′; Jan. 31, R.A. 17^h 35^m; Dec. S. 19° 17′) is a morning star in Scorpio rising at 4.40 a.m. on the 4th; on this date the planet is at *greatest brilliancy*. The telescope appearance is a thin crescent, 0·35 of the disc being illuminated on the 15th.

Mars (Jan. 1, R.A. 14^h 28^m; Dec. S. 13° 33′; Jan. 31, R.A. 15^h 40^m; Dec. S. 18° 41′) is a morning star, in Libra, rising at 2.47 a.m. on the 15th. The apparent diameter of the planet is increasing, being about 5″·5; this, however, is still too small for useful observation with telescopes of moderate power.

Jupiter (Jan. 1, R.A. 6^h 24^m; Dec. N. 23° 15′; Jan. 31, R.A. 6^h 9^m; Dec. N. 23° 25′) is very favourably placed for observation in the evening, rising at 2.23 p.m. on the 15th, and being due South at 10.39 p.m.

The bright moons can be seen in very small telescopes, or even in a pair of binoculars magnifying 6 or 8 times.

On the evening of the 26th the Moon will appear near the planet.

The equatorial diameter of the planet on the 16th is 45″·9, whilst the polar diameter is 3″·0 smaller.

The following table gives the satellite phenomena visible between 8 p.m. and midnight:—

Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.
Jan.				Jan.				Jan.			
4	II.	Ec. R.	11 3	13	I.	Tr. I.	9 52	24	IV.	Ec. D.	11 10
5	I.	Oc. D.	10 50		I.	Sh. I.	10 17	25	III.	Ec. R.	11 48
6	I.	Tr. I.	8 8	14	I.	Ec. R.	9 42	27	II.	Tr. I.	8 58
	I.	Sh. I.	8 22	20	II.	Tr. E.	9 29		II.	Sh. I.	10 26
	I.	Tr. E.	10 25		II.	Sh. E.	10 39		II.	Tr. E.	11 48
	I.	Sh. E.	10 39		I.	Tr. I.	11 37	28	I.	Oc. D.	10 32
7	III.	Tr. I.	9 56	21	I.	Oc. D.	8 46	29	II.	Ec. R.	8 5
	III.	Sh. I.	10 59		I.	Ec. R.	11 37		I.	Sh. I.	8 34
11	II.	Oc. D.	10 7	22	I.	Tr. E.	8 20		I.	Tr. E.	10 6
13	II.	Sh. E.	8 2		I.	Sh. E.	8 57		I.	Sh. E.	10 52
								30	I.	Ec. R.	8 1

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its reappearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress; "Ec. D." denotes disappearance of Satellite by Eclipse, and "Ec. R." its reappearance.

Saturn (Jan. 1, R.A. 22^h 51^m; Dec. S. 9° 25′; Jan. 31, R.A. 23^h 1^m; Dec. S. 8° 17′) is getting more to the west, and observations are only possible in the early evening. On the 15th, the planet is due south at 3.20 p.m. and sets at 8.38 p.m. The ring, which can be seen in small telescopes with moderate powers, appears to be gradually closing up; we are looking on the northern surface at an angle of only 5°.

Uranus (Jan. 16, R.A. 18^h 42^m; Dec. S. 23° 25′) was in conjunction with the Sun on the 31st of last month, and hence is unobservable.

Neptune (Jan. 16, R.A. 6^h 47^m; Dec. N. 22° 6′) being in opposition to the Sun at the early part of the month, is on the meridian at midnight. The planet is situated in Gemini, not far from the star 36 Geminorum.

METEOR SHOWERS:—

Date.	Radiant R.A.	Radiant Dec.	Name.
	h. m.		
Jan. 2-3	XV. 20	+53°	Quadrantids.
,, 17	XIX. 40	+53°	θ Cygnids.

Minima of Algol may be observed on the 17th at 11.31 p.m., the 20th at 8.20 p.m., and the 23rd at 5.9 p.m.

o Ceti (*Mira*) is unusually bright at this maximum, being equal in magnitude to α Arietis (2·1), nearly a fortnight before the computed date of maximum. Observations should be continued to determine the date of maximum and rate of diminution in brightness.

TELESCOPIC OBJECTS:—

Nebula.—Orion Nebula, situated in the sword of Orion, and surrounding the multiple star θ, is the finest of all nebulæ; with a 3 or 4 inch telescope, it is best observed when low powers are employed.

DOUBLE STARS.—β Orionis (Rigel), mags. 1 and 9, separation 9″. On account of the brightness of the principal star, this double is a fair test for a good object-glass of about 3-inch aperture.

δ Orionis, mags. 2 and 7, separation 35″; easy double.

ζ Orionis, triple, mags. 3, 6, and 10, separation 2″·5 and 56″; rather difficult in a 3-inch telescope.

λ Orionis, mags. 4 and 6, separation 4″·5; pretty double.

σ Orionis, triple, mags. 4, 8, and 7, separation 12″·5 and 42″.

See Announcement on page iii.

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